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INFORMAL REPORT

HYDRA SURVEY SYSTEM DEVELOPMENT, TEST AND EVALUATION

OCTOBER 1968

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NAVAL OCEANOGRAPHIC OFFICE
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ABSTRACT

The U. S. Naval Oceanographic Office (NAVOCEANO) received an urgent requirement in November of 1966 to conduct reconnaissance hydrographic surveys of the rivers and canals in the Mekong Delta of South Vietnam. As an interim measure NAVOCEANO tasked a Riverine Survey Team (RST), made up of both civilian and military personnel, in order to fulfill the immediate military/hydrographic requirements. The magnitude of the project revealed the need for a new approach to data acquisition, as conventional survey methods were too time-consuming and did not lend themselves to the widely varying environmental conditions found in the hostile Mekong Delta.

A prototype hydrographic digital positioning and depth recording system (HYDRA Survey System), compatible with existing electronic positioning systems and capable of data acquisition at speeds in excess of 20 knots, has been developed by the Research and Development Department of the U. S. Naval Oceanographic Office. This system is especially designed for military survey area applications.

The function of the HYDRA Survey System is to acquire electronic position and depth information, correlated with time, in a format suitable for automatic data processing and plotting on survey charts in the field.

Results of experimental test surveys conducted with the prototype HYDRA Survey System (HYDRA I) at AUTEC Site 1 in the Bahamas, and the modified HYDRA Survey System (HYDRA II) near Ft. Walton Beach, Florida, are highlighted with special emphasis given to future applications.

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Director
Hydrographic Development Division

DATE: 11 Oct 1968

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INTRODUCTION

The 2,625 mile Mekong River, the World's tenth greatest river in terms of the volume of water it carries, plays a vital role in the national economies of Laos, Thailand, Cambodia and particularly South Vietnam. A wild and torrential river rising in the high Himalayas, the Mekong changes character totally in the lower basin where it becomes a slow moving giant with tributaries and canals covering thousands of square miles. This lower basin or delta zone in South Vietnam is commonly referred to as the Mekong Delta (See Figure 1).

The Mekong Delta region encompasses some 15,000 square miles or about one fourth of the total area of South Vietnam and contains approximately one half of the country's estimated population of 17 million. This area features the most outstanding navigational and drainage canal system in the world. As a consequence of construction started about 800 A.D. by the Khmer Dynasty, and continuing to more recent times, there are some 1,500 miles of navigable waterways in this delta region. Supplementing this extensive navigational system are 2,500 miles of canals classified as primary, secondary, or tertiary, plus innumerable meandering streamlets and drainage ditches.

Unfortunately, while South Vietnam possesses a highly developed riverine network, it lacks up-to-date hydrographic charts. In order to improve commerce an effort was made by the French to chart the major coastal and inland waterways. These charts, however, were often inaccurate and of questionable value. They were nevertheless the best and often the only coverage available in many areas until the past several years.

An effort was undertaken in 1960 by the International Cooperation Administration of the United States to comprehensively survey and evaluate one thousand miles of primary canals for the purpose of determining a priority ranking for restoration of approximately 240 miles of the more important waterways. Included in these well planned survey procedures were reconnaissance surveys, tying navigational aids to modern geodetic control, tide and current studies, and channel profiling with echo sounders. This ambitious program ceased the same year because of increasing hostilities encountered by survey parties in the Delta.

Hostilities increased to such an extent that in 1965 the United States began to take an active part in military operations in South Vietnam in accordance with provisions set forth by the South East Asia Treaty Organization (SEATO). To support these military operations, there developed an urgent requirement for hydrographic survey data within this vast network of inland waterways. The Navy's area of responsibility was thus extended from oceanic and coastal waters into the vastly more complex, challenging and all too often

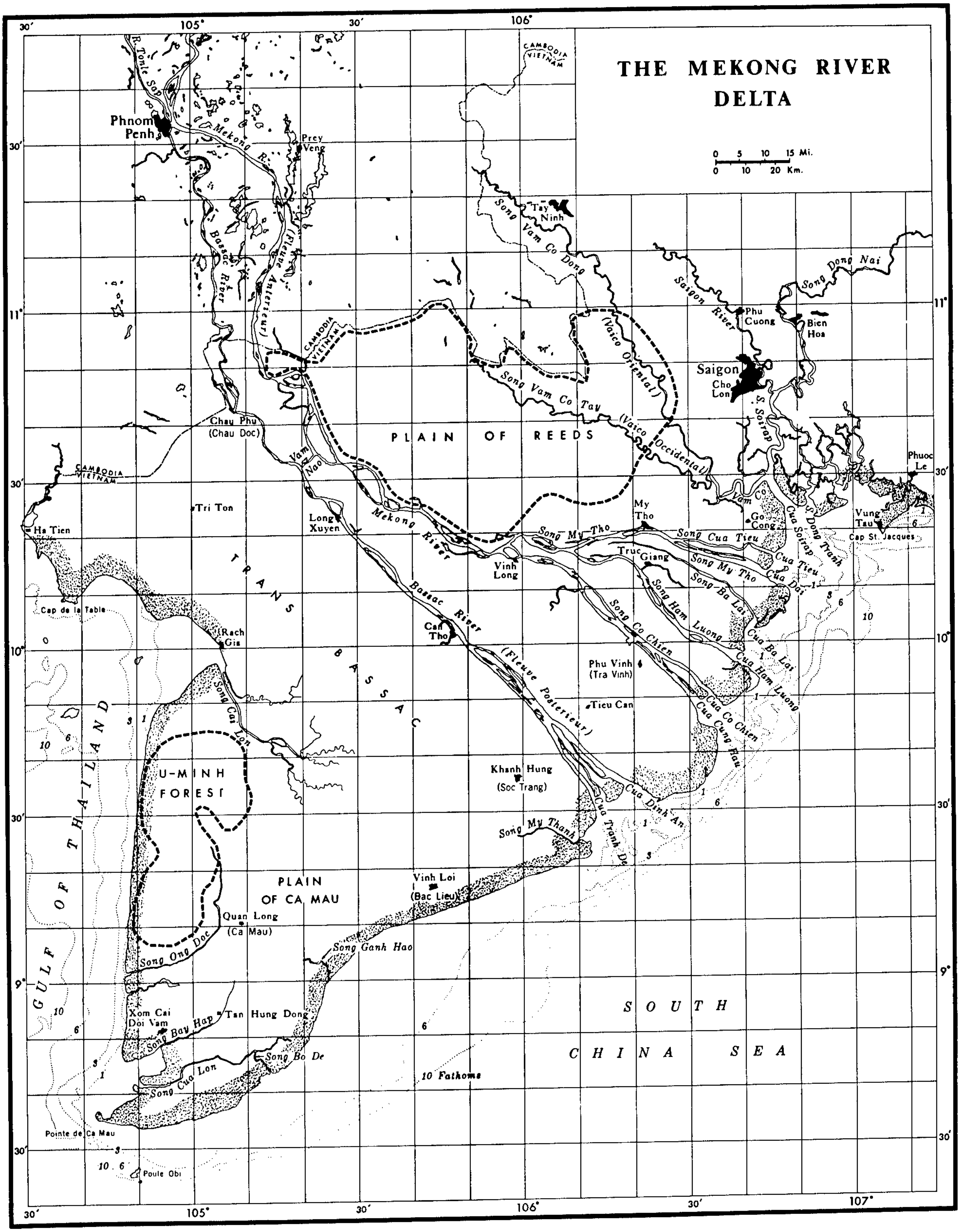


FIGURE 1. THE MEKONG RIVER DELTA

hostile delta area. Movement of war materials and manpower in this drowned terrain is limited to the main rivers and channels employing an ingeneous, but fragile fleet of fiberglass patrol boats or the armored, but painfully slow landing craft.

To assure safe transits of craft, men, and materials along these intricate natural and man-made water highways, we must first acquire accurate knowledge of the hydrographic conditions prevailing along all potentially useful arteries. Thus, requirements exist for a system capable of operating in enemy infested areas and of acquiring, processing, and recording hydrographic data at speeds far exceeding present day conventional survey methods.

The Hydrographic Digital Positioning and Depth Recording System (HYDRA Survey System) has been developed by the Research and Development Department of the U. S. Naval Oceanographic Office to meet this requirement (see Figure 2). The HYDRA Survey System satisfies not only the existing high-speed requirements, but provides growth capability to meet future fully automated survey needs. Survey data, consisting of positions and depths correlated with time, are recorded at speeds up to 20 knots on magnetic tape aboard the survey vehicles.

In order to expedite the processing and plotting of data recorded by the HYDRA Survey System in field operations, an additional requirement exists for a mobile, self-sufficient, automated data processing and plotting facility. To satisfy this requirement, an ADP system with a TRW-130 (AN/UYK-1) Computer and an EAI X-Y Plotter was obtained from the USAF Rome Air Development Center (RADC) by the Research and Development Department of NAVOCEANO and is currently being modified to accept and process magnetic tapes generated by the HYDRA Survey System. A 7 by 12 foot, highly-mobile, wheel-mounted, electrical equipment shelter used by the Air Force as a mobile photo interpretation center has been received from RADC for housing the HYDRA ADP system. Ideally, the HYDRA ADP Facility will be located near the area where the HYDRA Survey System will be operating. At the completion of a typical riverine survey mission, magnetic tape containing the recently recorded hydrographic data will be taken to the ADP facility for processing. The end product will be a "smooth sheet" available for immediate field use when shoreline, topographic detail, and survey control are added from various charts and aerial photography. Because the HYDRA Survey and ADP Systems were designed around the high mobility concept, it will be possible to relocate either or both systems to priority areas within a narrow time frame by land, sea, or air transportation.

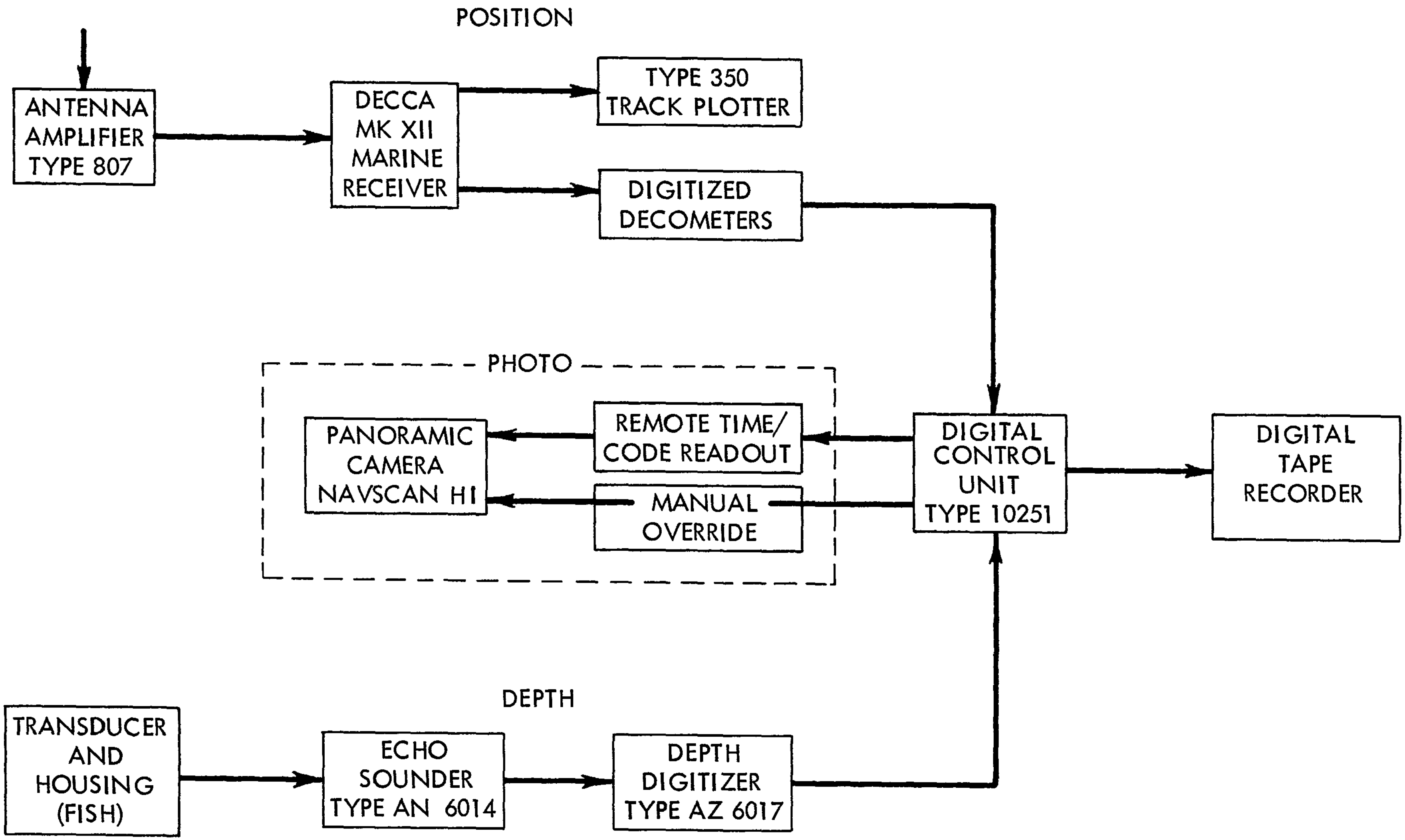


FIGURE 2. SCHEMATIC OF THE PROTOTYPE HYDRA SURVEY SYSTEM (HYDRA I)

GENERAL DESCRIPTION

A. HYDRA Survey System Components and Requirements

The HYDRA Survey System can be considered as performing three separate functions: position fixing, depth acquisition, and data recording (see Figure 3).

1. Position Fixing System and Components are as follows:

a. Decca Electronic Positioning

b. Decca Mark XII Marine Receiver

c. Decca Mark XII Decometer Digitizer Unit

d. Decca Mark XV Airborne Receiver

a. Decca Electronic Positioning. Electronic positioning for the HYDRA Survey System can be achieved by using either the Decca Mark XII Marine Receiver, which was used in the prototype HYDRA Survey System (HYDRA I), or the solid state Mark XV Airborne Receiver, which is being used in the second generation system (HYDRA II).

Electronic coordinates are resolved by reception of time phase pulses from an existing Decca transmission chain in Vietnam established by the U. S. Army for positioning helicopters and other tactical aircraft. Figure 4 shows the physical location and accuracy contours of these transmitters. The master station is located at Baria, the green station is located at Phan Thiet, about 75 miles up the coast from Baria, the red station is situated at Tay Ninh near the Cambodian border, and the purple station is on Con Son Island.

These four transmitters generate three families of hyperbolic lines of electronic position. The accuracy contours shown are in yards. In the Mekong Delta area, fixes generally do not have errors in repeatability greater than 200 yards, with the principal areas of interest having errors in position of less than 100 yards. As an example, the computed error at the mouth of the Bassac River is 90.8 yards and at the Long Tau River 60.3 yards.

Fix errors in these ranges, while extremely high for precision survey work, do not seriously hamper reconnaissance hydrographic surveys in the rivers and canals. Reports from NAVOCEANO's Riverine Survey Team in Vietnam indicate Decca positioning is quite satisfactory, and that any necessary adjustment or shifting of positions is not difficult.

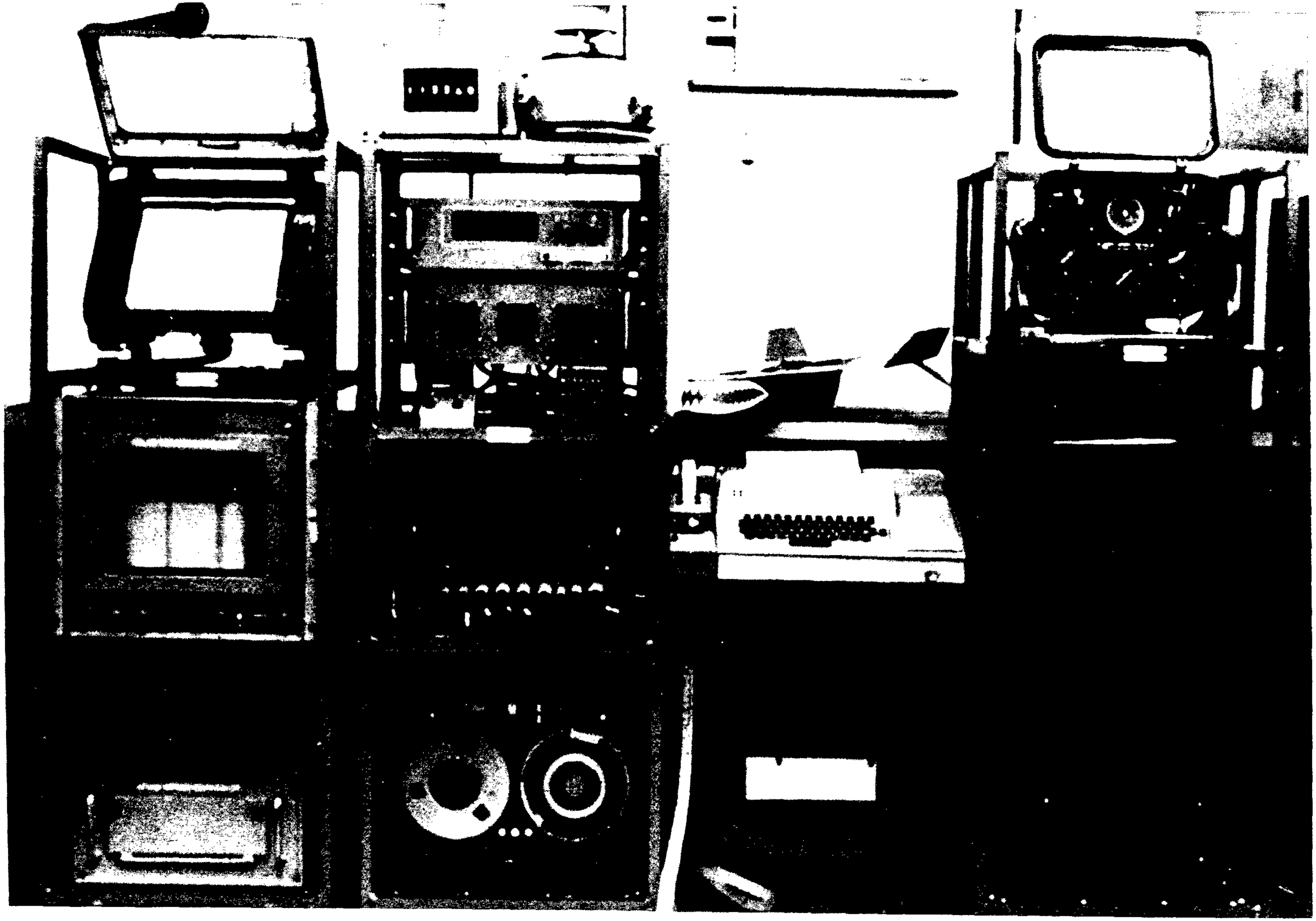


FIGURE 3. PROTOTYPE HYDRA SURVEY SYSTEM

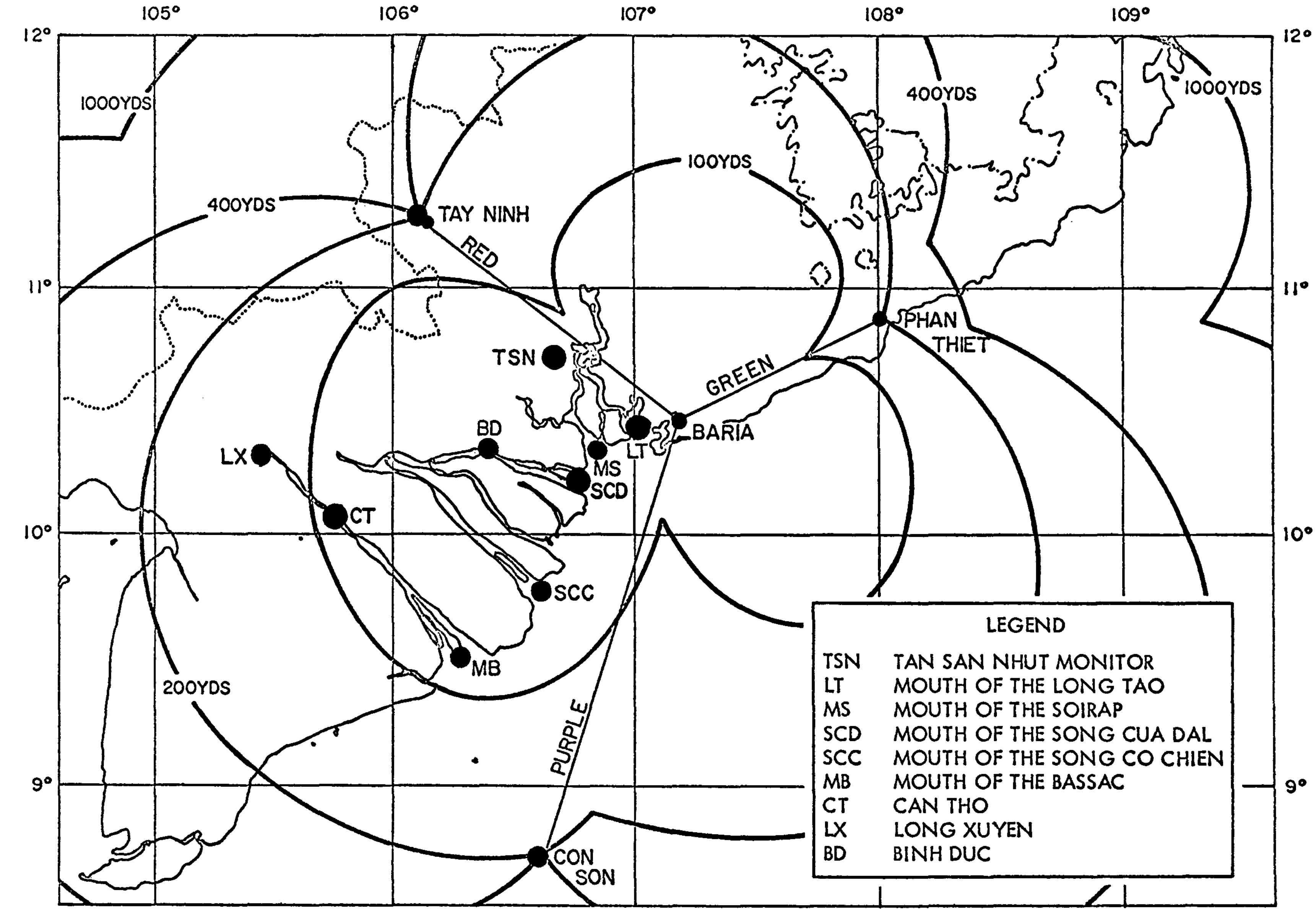


FIGURE 4. DECCA STATION LOCATION AND ACCURACY CONTOURS IN THE MEKONG DELTA, VIETNAM

b. Decca Mark XII Marine Receiver. The Mark XII Receiver is currently being used by the NAVOCEANO Riverine Survey Team in Vietnam on Armored Troop Carriers (A.T.C.'s) operating in the Mekong Delta. This receiver is a proven and highly reliable piece of electronic equipment which satisfied the initial requirements for the prototype HYDRA Survey System. Three dials or Decometers, red, green, and purple, display readings or lane values which identify the location of the receiver within the Decca Net. A lane identification meter provides a check on the Decometer lane readings and also enables the operator to set in the correct lane values initially.

c. Decca Mark XII Decometer Digitizer Unit. In automating the output from the Mark XII Receiver, positional data is translated into computer language that can be recorded on magnetic tape. Consequently, the Decca lane values which appear on the red, green, and purple Decometers must be converted into a digital format. A Decometer Digitizer Unit was designed to accept the Decca lane values from the three Decometers, convert these values to a digitized form, and relay them to the Digital Control Unit (DCU).

d. Decca Mark XV Airborne Receiver. By utilizing solid state technology in the design of a receiver, a high resolution, light weight electronic positioning instrument has recently been produced by Decca. The output from this receiver is in a digital format rather than the conventional analog format displayed by the Mark XII.

With the successful integration of the Decca Mark XV Airborne Receiver into the HYDRA concept, a considerable reduction in weight and size of packaging has resulted.

2. Depth Finding

To provide reliable and accurate depth determination at high speeds, the Atlas Digital Depth Finding System was selected for HYDRA. The Atlas components are listed below:

a. The Atlas AN 6014 Echo-Sounder

   i. The Atlas Echo-Sounder Electronic Unit

   ii. The Atlas Echo-Sounder Recording Unit

b. The Atlas Transducers

c. The Atlas AZ 6017 Depth Digitizer

a. Atlas Echo-Sounder Type AN 6014. The Atlas AN 6014 Echo-Sounder is a unique development in the field of depth finding. All of the well-known short comings of echo-sounders have been overcome and its advanced design techniques insure reliability and accuracy in-the-order of 6 inches in 66 feet.

This unit contains two basic components, the electronic and recording units. The function of the electronic unit is to convert electrical impulses into sound waves, transmit these sound waves from the Atlas transducers to the river or ocean bottom, receive and convert the resulting echoes back into electrical impules, and transmit these data to the echo-sounder recording unit and depth digitizer. The electronic circuitry in this unit utilizes solid-state modular techniques including micrologic circuitry. Transmission on two frequencies simultaneously, time dependent volume control, and automatic gain control, are a few of the special features of this unit. The function of the recording unit is to display depths in analog form on paper as they are received from the electronic unit. A unique feature of this unit makes it possible for a visual indication to be given when depth data is being properly digitized and recorded on magnetic tape. This indicator appears as a second trace located beneath the depth trace on the analog paper (see Figure 5).

b. Atlas Transducers. The Atlas Echo-Sounder is provided with two transducers, one operating at 30 kHz and the other at 210 kHz. Both transducers are mounted in a streamlined fiberglass housing which is rigged over-the-side (see Figures 6 and 7). This specially designed housing reduces signal interference normally caused by cavitation, thus permitting high speed operations. Weighing only 33 pounds, the Atlas transducer configuration has been successfully tested at speeds in excess of 20 knots.

c. Atlas AZ 6017 Depth Digitizer. This fully solid-state unit forms the link between depth acquisition and data recording. The traveling time between transmission pulse and bottom echo, as measured by the echo-sounder, is converted into digital output values. The primary task of the digitizer is to distinguish the first bottom echo from reverberation noise, ambient noise, or multiple echo. Continuous operation over areas of considerably varying depth, without adjusting any operating element, is made possible by several unique design features. Digital depth information is also read out on a nixie tube display on the unit.

3. Data Correlation and Recording

a. Digital Control Unit (DCU)

b. Kennedy Model 2062 Tape Recorder

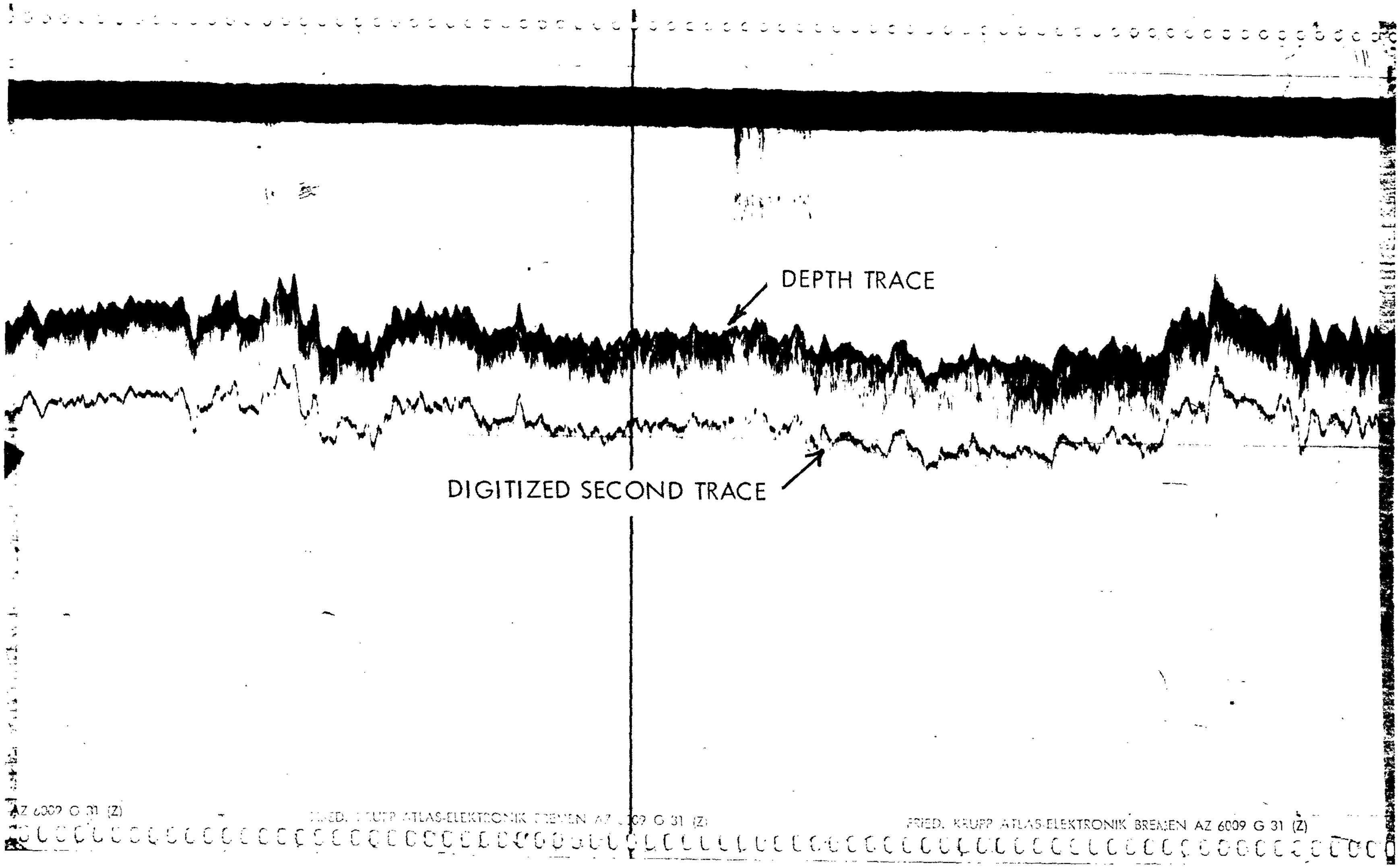


FIGURE 5. TYPICAL BOTTOM TRACE FROM ATLAS ECHO-SOUNDER. LOWER TRACE INDICATES DATA HAS BEEN DIGITIZED AND RECORDED ON MAGNETIC TAPE

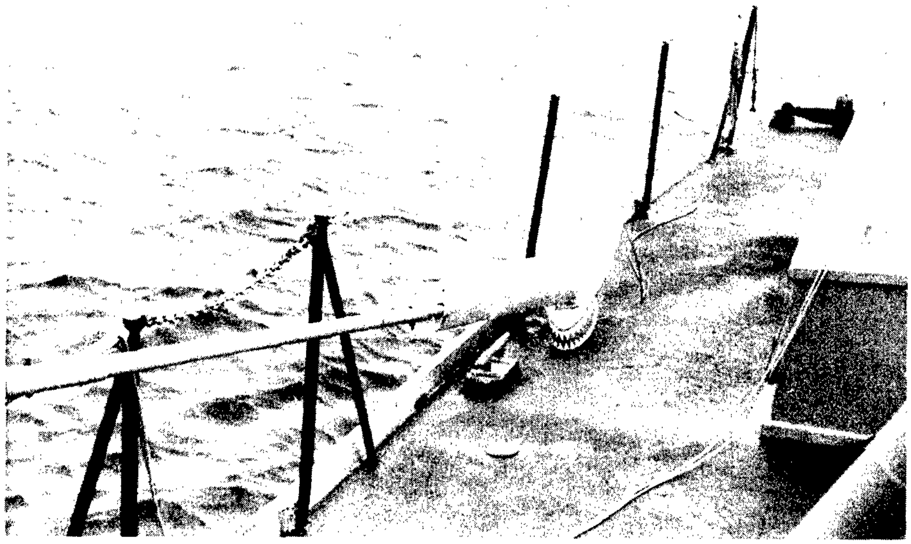


FIGURE 6. VIEW OF ATLAS "FISH" SHOWING STREAMLINED TRANSDUCER HOUSING

FIGURE 7. ATLAS TRANSDUCER MOUNTED OVER-THE-SIDE
FOR SURVEY OPERATIONS

a. Digital Control Unit. Before digitized data from the Decca Receiver and the Atlas Echo-Sounder can be recorded on magnetic tape, it must be properly correlated and sequenced by the Digital Control Unit (DCU).

The DCU interrogates the Atlas Depth Digitizer, the red, green, and purple lane values, and stores these data together with an internally generated time of day and code signal. These stored data are then scanned sequentially for recording by the magnetic tape unit. Time of day, to the nearest second, is internally generated by a crystal controlled clock operating at 100 kHz. This clock provides the internal timing signals for all program functions. A six digit switch mounted on the front panel of the Digital Control Unit provides the facility for setting a numerical combination for a coded reference. This input can be used to identify the survey run number, operating area, day and month, river name and so forth.

The Atlas Digitizer is interrogated and its output, in the form of four digits of depth, is stored ready to be sequentially scanned and recorded on magnetic tape in its correct program position after the time and code. At the same instant that the depth is interrogated, the red, green, and purple lane values are interrogated and the BCD coded output for each is stored ready for recording. A typical record block shown in Figure 8 illustrates the form in which the stored data is recorded on magnetic tape.

The scanning of all stored information, regardless of record rate, is accomplished in 100 milliseconds. All functions necessary to drive the magnetic tape recorder, such as record pulse and correct logic are supplied by the Digital Control Unit.

b. Kennedy Model 2062 Tape Recorder. This magnetic tape unit records digitized data as it becomes available from the Digital Control Unit. Combining high speed with extremely accurate stepping action, the Model 2062 writes tapes which may be used on any IBM compatible tape transport for computer input.

Two modifications were required to make the Model 2062 compatible with other HYDRA Survey System components: (1) The power requirements were changed from 115 VAC to 24 VDC, and (2) the unit was repackaged to meet the severe tropical environmental conditions prevailing in Vietnam.

4. Mountings and Power

To provide optimum flexibility, the HYDRA Survey System was designed around the piggy-back concept. Such a design permits the system to

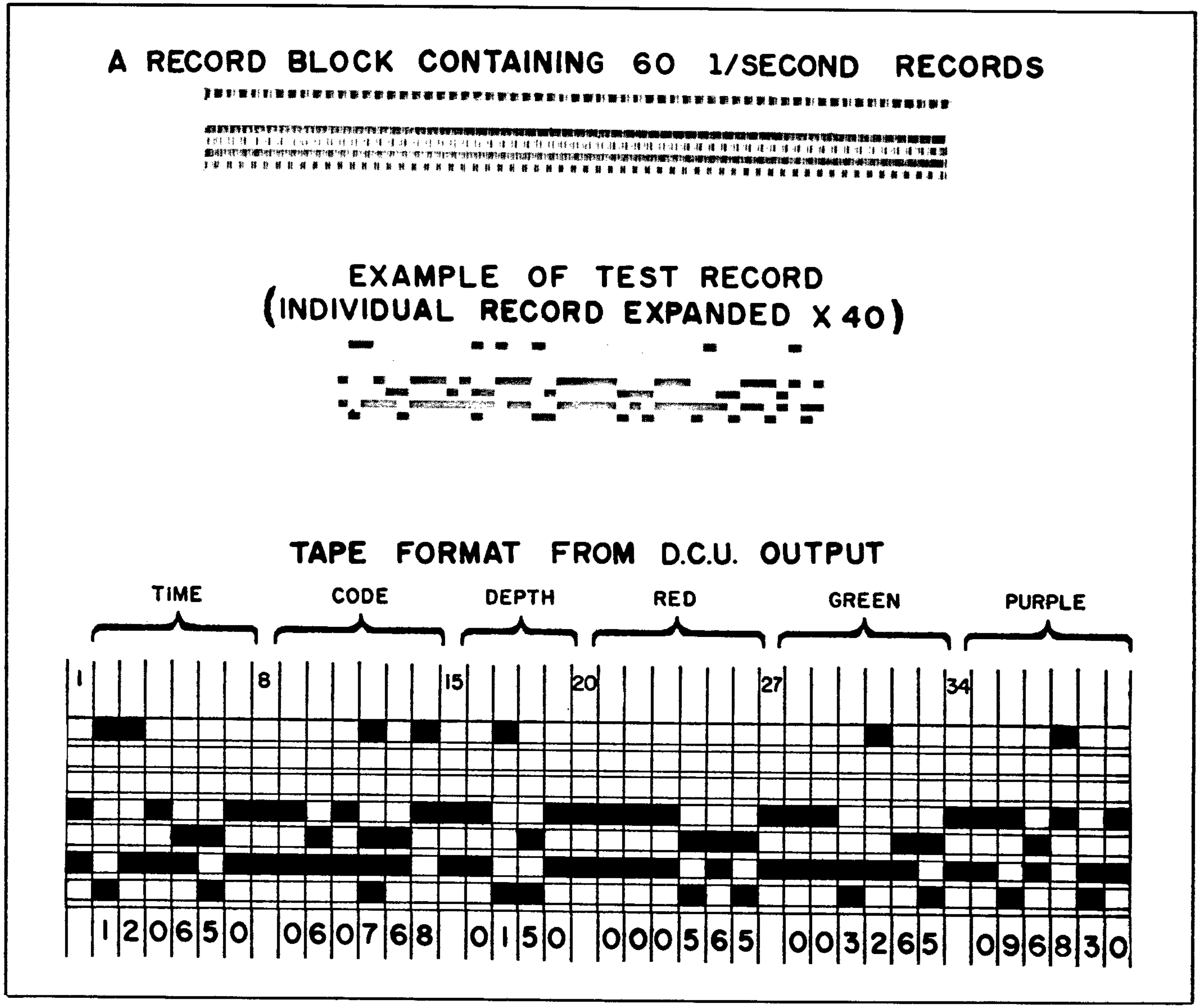


FIGURE 8. BCD OUTPUT AS RECORDED ON MAGNETIC TAPE

be readily installed or removed from a craft as military operations or opportunity may dictate without requiring any modification to the craft. System components are mounted in convenient size containers which may be stacked and placed aboard a variety of river craft.

Operating power requirements for the HYDRA Survey System are 22-28 VDC at 8 amps. In most situations these requirements can be satisfied by using power from the ship's electrical system to keep two 24-volt batteries constantly charged. In a situation where no power is available aboard, shore-based chargers will be used when the system is not in operation.

5. Panoramic Photography

During the early stages of development, what was thought to be a unique complimentary component was tied into the HYDRA concept. This component was the NavScan panoramic camera. The primary purpose of NavScan photography is to produce horizontal 350° panoramic views of the local topographical environment referenced to recording time, position, and depth. It was hoped that these photographs would provide a wealth of intelligence data close to the terrain's surface.

Repeated tests, however, proved the panoramic camera to be unreliable when used with the HYDRA Survey System. Camera circuitry caused interference in digitizing depth data and skips in data recording. Problems were also encountered in processing and analyzing NavScan photographs. Due to its limited contribution the NavScan camera has now been eliminated from the HYDRA concept.

B. Hydra Automated Data Processing System

The HYDRA Automated Data Processing System (HYDRA ADP) performs two distinct functions, data processing and plotting (see Figure 9).

1. Data Processing

Data recorded on magnetic tape generated by the HYDRA Survey System will be processed by a TRW-130 (AN/UYK-1) computer. As a result of data processing, a paper tape will be generated by a teletype reperforator for plotting and a second magnetic tape will be generated for other uses.

2. Plotting

The plotter tape generated by the computer will be in a suitable format for acceptance by an Electronics Associates Incorporated (EAI) X-Y

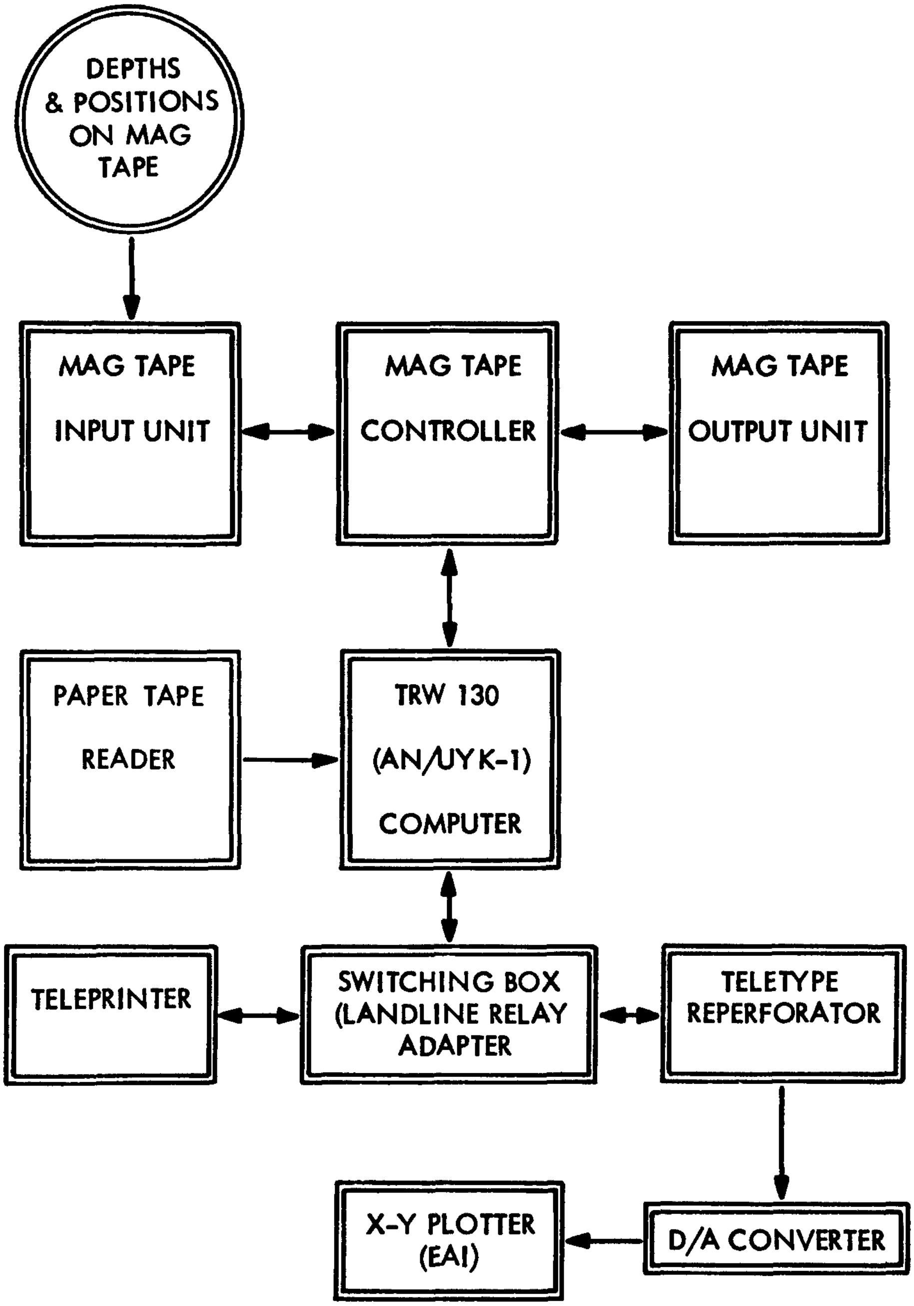


FIGURE 9. SCHEMATIC OF PROTOTYPE HYDRA ADP SYSTEM

Plotter. The end product will be in the form of a smooth sheet containing plotted hydrographic data.

TEST AND EVALUATION

A. Prototype HYDRA Survey System (HYDRA I)

1. Background

2. Test Objectives

3. Field Tests and Results

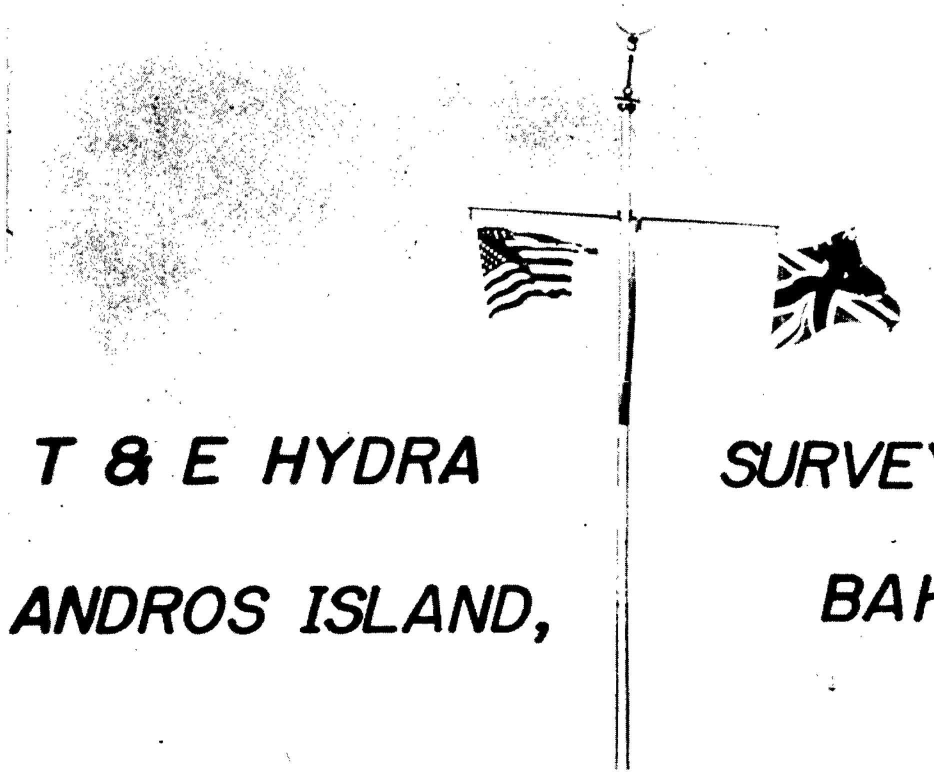
4. Evaluation and Modifications

1. Background

The problem of designing and assembling the first portable automated hydrographic digital positioning and depth recording system (HYDRA I) was successfully accomplished by Decca Survey Systems Inc., of Houston, Texas, under a contract with the Naval Oceanographic Office. While many of the components comprising the prototype HYDRA System were already in existence, the problem did exist of combining the operation of these components into a smoothly functioning system. Decca Survey System's Research Engineer, Mr. Terrance Jones, had the responsibility of achieving this goal.

Work on the system was begun in early summer of 1967. The project's completion date was tentatively set for 15 January 1968. During fabrication and component assembly many unusual technical problems were encountered including the design of the Digital Control Unit. Credit for this achievement is given prinicpally to Mr. Terence Jones, who demonstrated considerable skill and knowledge in designing and building the DCU unit.

In mid-January of 1968 HYDRA was ready for bench testing. The tests were conducted at the Houston Decca facility and were highly successful, thus indicating that the system was ready for extensive field evaluation tests preferably in an area where environmental conditions would be similar to those of the Mekong Delta Region of South Vietnam. The site selected for these tests was the Atlantic Undersea Test and Evaluation Center (AUTEC), Andros Island, Bahamas (see Figure 10). Besides satisfying the requirement for suitable environmental surroundings, the AUTEC range also provided computer facilities, use of a Decca Chain for electronic positioning control similar to that being used in Vietnam, and other essential logistical support (see Figure 11).



T & E HYDRA SURVEY SYSTEM

ANDROS ISLAND, BAHAMAS

FIGURE 10. AERIAL PHOTO OF AUTEC SITE 1, ANDROS TOWN, BAHAMAS

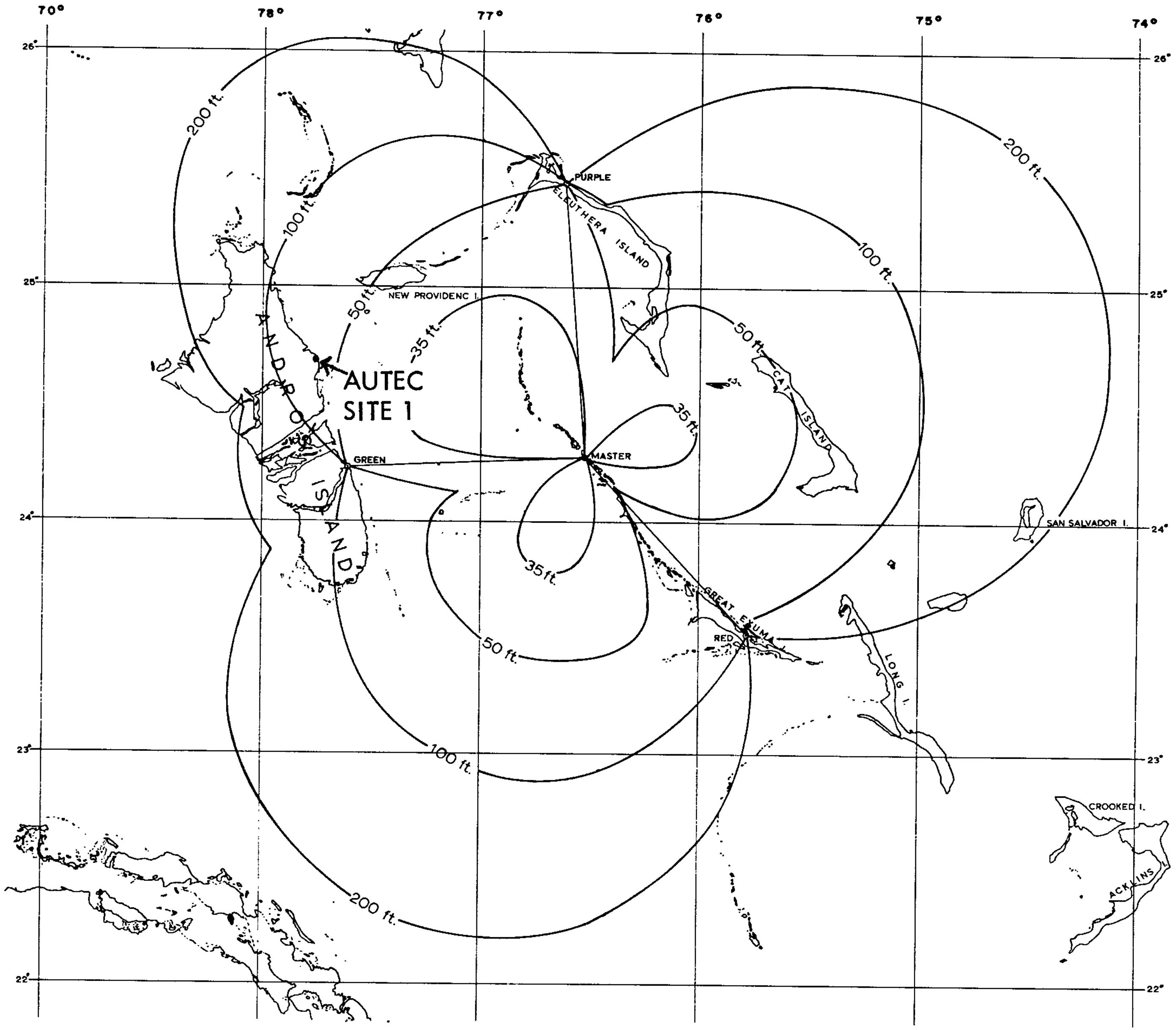


FIGURE 11. DECCA STATION LOCATION AND ACCURACY CONTOURS IN THE BAHAMAS

2. Test Objectives

The overall objective of the test and evaluation effort at AUTEC was twofold. One objective was to field test and make fully operational the equipment comprising the HYDRA Survey System. The second objective was to train HYDRA personnel to such a level of proficiency that they could at a later date, train field personnel in system operation and routine maintenance. The time period selected for the tests was 2 February - 28 February, 1968.

3. Field Tests and Results

Soon after the field party arrived at AUTEC on 3 February, a 63-foot craft was assigned to the HYDRA test group. Upon arrival of the HYDRA Survey System from Houston, Texas, installation of the various components was begun aboard the AVR-53 (see Figure 12). Within two days, installation (see Figure 13) was completed and underway speed trials were begun in the area of the AUTEC Site 1 to evaluate the performance of the Atlas transducer and give the system a general check out.

Problems in data recording and computer programming were immediately uncovered with the generation of the first data tape by HYDRA. After an exhaustive component check and program review of the HYDRA Survey System it became apparent that several major circuitry modifications would be required. Mr. Jones of Decca Survey Systems Inc., was advised of the difficulties encountered with the system and he departed immediately for AUTEC.

Upon arrival Mr. Jones made the required modifications to the tape recorder and the Digital Control Unit. At this juncture another systems check out was initiated to evaluate the results of the modifications. A HYDRA output tape was generated and successfully run on a CDC 3400 computer, thus indicating that the circuitry problems had been solved. After reviewing the computer output, several minor changes were made in the printout format. No further data processing problems were encountered during the test and evaluation effort. There were, however, minor Decometer encoder problems, but they did not hinder the operation.

Extensive underway tests were then conducted in the channels leading into the various AUTEC sites and along the offshore reefs to determine system performance and accuracy. Results from this effort were most impressive (see Figure 14). Within minutes after docking, data stored on magnetic tape aboard the AVR was processed on the CDC 3400 computer. Coded digitized positional information was converted by the computer into northings and eastings, latitudes and longtudes. These computed values were then printed out along with fix

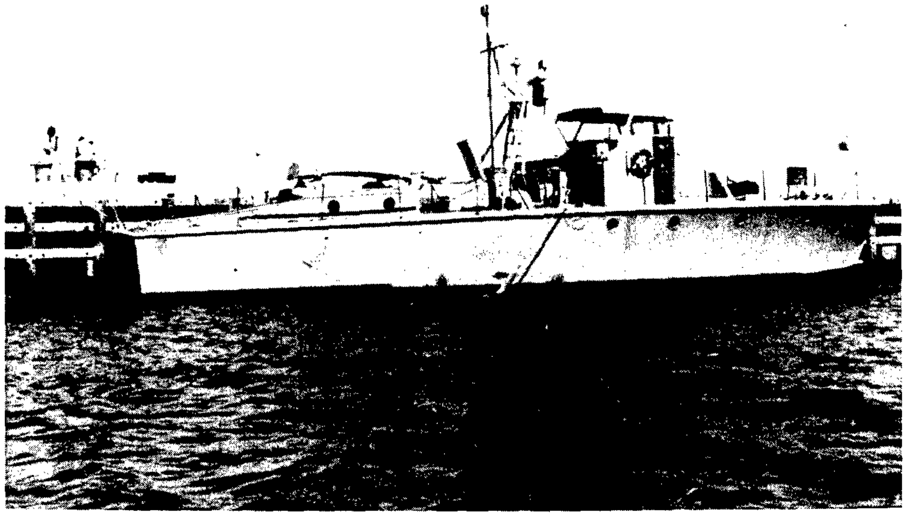


FIGURE 12. AVR 53 ON WHICH THE HYDRA SURVEY SYSTEM WAS MOUNTED

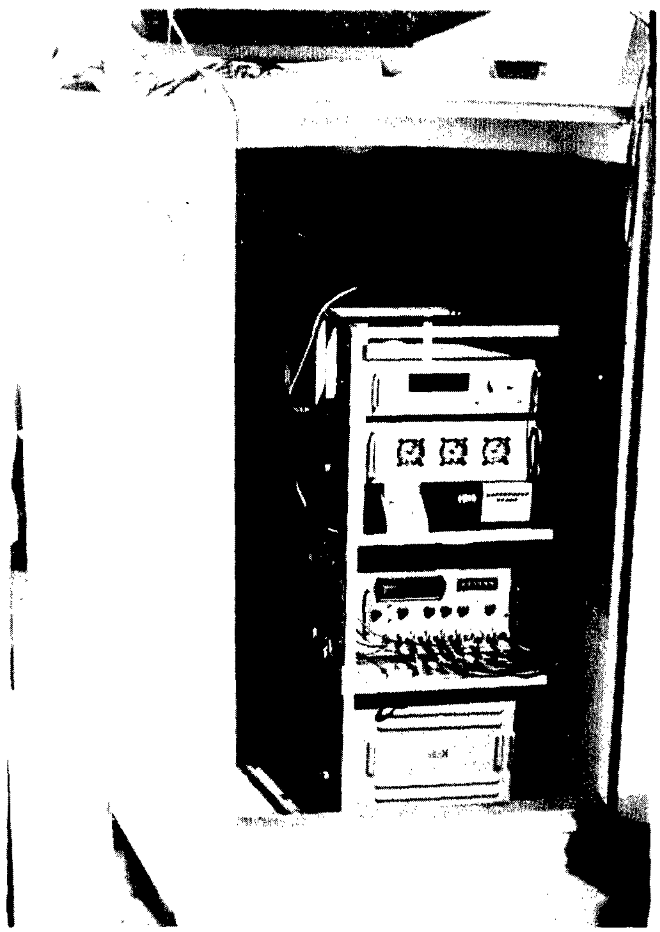


FIGURE 13. DIGITAL DISPLAY RACK

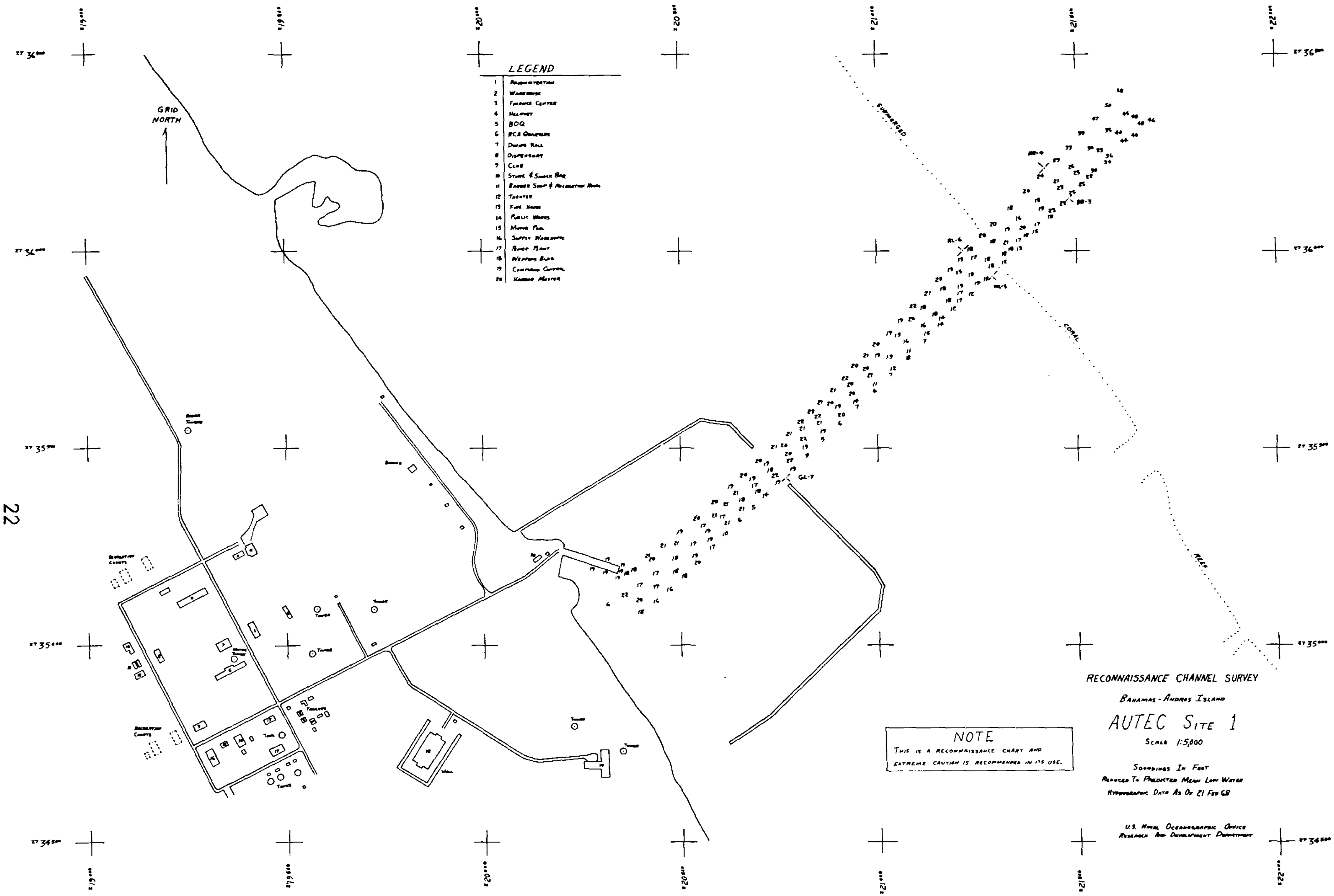


FIGURE 14. RECONNAISSANCE CHANNEL SURVEY OF AUTEC SITE 1

numbers, depth values (in feet), reference code and time. Figure 15 is an example of a typical HYDRA data sheet. After processing on the CDC 3400 computer, the data was shipped back to NAVOCEANO for plotting on an X-Y automated plotter, as this equipment was not available at AUTEC.

In order to determine the possibility of discrepancies in the electronic (Decca) fixes, geodetically related position determinations were made using two optical tracking instruments. The comparative results indicated the existence of a small uniform shift over the primary survey area. A correction factor was determined to compensate for the shift. A shift procedure is also currently being used in Vietnam survey operations.

The test and evaluation of the prototype HYDRA Survey System was concluded with all scheduled phases successfully completed. The evaluation of the performance of the system would indicate that the HYDRA Survey approach to river survey operations is both feasible and practical.

4. Evaluation and Modifications

Although the prototype HYDRA Survey System functioned satisfactorily during the initial tests at AUTEC, several significant modifications were deemed desirable before further field evaluation. The configuration, as tested, was too heavy and cumbersome for true piggy-back operations. More component integration and changes in packaging were decided upon. A total system weight of 160 pounds was the goal set for HYDRA II.

Contributing towards substantial reductions in size and weight was a decision by the U. S. Army to convert the Decca transmission chain in South Vietnam from a Mark V to a Mark X Chain. This conversion was scheduled for completion in early May of 1968. For the first time the use of a Decca Mark XV Airborne Receiver became feasible. A modification contract was awarded to Decca Survey Systems, Inc., to interface the new receiver into the system and completely repackage the equipment within a 60 day period. As a result of this contract, HYDRA II became a reality.

B. Modified HYDRA Survey System (HYDRA II)

1. Background

2. Test Objectives

3. Field Tests, Results, and Evaluation

ID	RATE 1	RATE 2	RATE 3	VALUE	NORTHING	EASTING	LATITUDE	LONGITUDE	TIME
1	0A 9.47	0B36.42	0A57.41	29.2	3364174.5	545106.8	30 24 37.44	86 31 49.39	10 8 1
2	0A 9.48	0B36.42	0A57.42	29.2	3364166.0	545110.1	30 24 37.17	86 31 49.27	10 8 2
3	0A 9.47	0B36.43	0A57.43	29.2	3364173.9	545100.5	30 24 37.43	86 31 49.63	10 8 3
4	0A 9.48	0B36.45	0A57.43	29.2	3364164.3	545091.3	30 24 37.12	86 31 49.97	10 8 4
5	0A 9.48	0B36.46	0A57.44	28.9	3364163.7	545085.1	30 24 37.10	86 31 50.21	10 8 5
6	0A 9.48	0B36.47	0A57.44	28.9	3364163.1	545078.9	30 24 37.08	86 31 50.44	10 8 6
7	0A 9.49	0B36.48	0A57.45	28.7	3364154.1	545075.9	30 24 36.79	86 31 50.55	10 8 7
8	0A 9.49	0B36.49	0A57.44	28.4	3364153.5	545069.7	30 24 36.77	86 31 50.78	10 8 8
9	0A 9.50	0B36.48	0A57.45	28.2	3364145.6	545079.3	30 24 36.51	86 31 50.43	10 8 9
10	0A 9.50	0B36.51	0A57.49	28.2	3364143.9	545060.5	30 24 36.46	86 31 51.13	10 8 10
11	0A 9.52	0B36.54	0A57.47	28.0	3364125.2	545048.5	30 24 35.85	86 31 51.58	10 8 11
12	0A 9.51	0B36.54	0A57.45	28.0	3364133.7	545045.1	30 24 36.13	86 31 51.71	10 8 12
13	0A 9.56	0B36.55	0A57.50	28.0	3364090.7	545055.5	30 24 34.73	86 31 51.32	10 8 13
14	0A 9.51	0B36.52	0A57.47	28.0	3364134.8	545057.6	30 24 36.16	86 31 51.24	10 8 14
15	0A 9.52	0B36.55	0A57.56	28.0	3364124.6	545042.2	30 24 35.83	86 31 51.82	10 8 15
16	0A 9.54	0B36.55	0A57.50	27.9	3364107.7	545048.9	30 24 35.28	86 31 51.57	10 8 16
17	0A 9.52	0B36.56	0A57.48	27.7	3364124.0	545036.0	30 24 35.82	86 31 52.05	10 8 17
18	0A 9.56	0B36.61	0A57.54	27.7	3364087.2	545018.1	30 24 34.62	86 31 52.73	10 8 18
19	0A 9.52	0B36.56	0A57.48	27.2	3364124.0	545036.0	30 24 35.82	86 31 52.05	10 8 19
20	0A 9.51	0B36.60	0A57.49	27.2	3364130.3	545007.6	30 24 36.02	86 31 53.11	10 8 20
21	0A 9.50	0B36.56	0A57.48	26.9	3364141.0	545029.3	30 24 36.37	86 31 52.30	10 8 21
22	0A 9.51	0B36.59	0A57.50	26.9	3364130.8	545013.9	30 24 36.04	86 31 52.88	10 8 22
23	0A 9.50	0B36.58	0A57.49	26.9	3364139.9	545016.8	30 24 36.33	86 31 52.77	10 8 23
24	0A 9.51	0B36.60	0A57.50	26.9	3364130.3	545007.6	30 24 36.02	86 31 53.11	10 8 24
25	0A 9.51	0B36.61	0A57.50	26.9	3364129.7	545001.4	30 24 36.00	86 31 53.35	10 8 25
26	0A 9.52	0B36.61	0A57.50	26.9	3364121.2	545004.7	30 24 35.73	86 31 53.22	10 8 26
27	0A 9.52	0B36.63	0A57.51	26.9	3364120.1	544992.2	30 24 35.69	86 31 53.69	10 8 27
28	0A 9.52	0B36.64	0A57.51	26.9	3364119.5	544986.0	30 24 35.67	86 31 53.93	10 8 28
29	0A 9.53	0B36.65	0A57.51	26.9	3364110.4	544983.1	30 24 35.38	86 31 54.04	10 8 29
30	0A 9.53	0B36.67	0A57.57	26.6	3364109.3	544970.6	30 24 35.34	86 31 54.51	10 8 30

FIGURE 15. ACTUAL PRINTOUT RESULTS FROM TEST SURVEY IN THE BAHAMAS

1. Background

The original packaging scheme in the HYDRA I System consisted of three metal racks standing 4 1/2 feet high, with a combined weight of over 690 pounds (see Figure 16). The modified HYDRA II package is a one rack configuration standing 3 feet high and weighing 153 pounds (see Figure 17), thus providing for a total reduction in size and weight of 40 cubic feet and 537 pounds respectively. This new packaging arrangement reflects logistic versitility in that this rack may be transported as one piece, or broken down into three distinct units ("zero" type containers - see Figure 18). With these modifications, the HYDRA II System meets the size and weight requirements of reconnaissance survey craft presently being utilized in Vietnam riverine survey operations.

Depth information obtained during conventional hydrographic surveys is delineated graphically on fathograms. Problems with graphic resolution and paper recording volume aboard survey craft are negligible when speeds less than 15 knots are maintained. At speeds above 20 knots the paper record must pass under the stylus at ever increasing rates to maintain good resolution. When survey speeds of 30 to 50 knots are reached, the rate at which paper records are generated within the recorder becomes prohibitive.

Although not an integral feature of HYDRA II, the Atlas Echo-Sounder analog portrayal sub-system (see Figure 19) is attached via three cables to the central system. The role of this component centers primarily around confidence building in digital depth recording techniques.

The graphic recorder sub-system entails various features as depicted in Figures 20, 21, and 22 respectively. The first is choice of depth range in increments from 0-280 meters and coded accordingly along the upper edge of the fathogram. The second feature presented is variable paper speed. Divisions of 1 1/4, 2 1/2, 5 and 10 centimeters per minute are available. The third feature is the automatic one minute event mark which facilitates scaling fathograms.

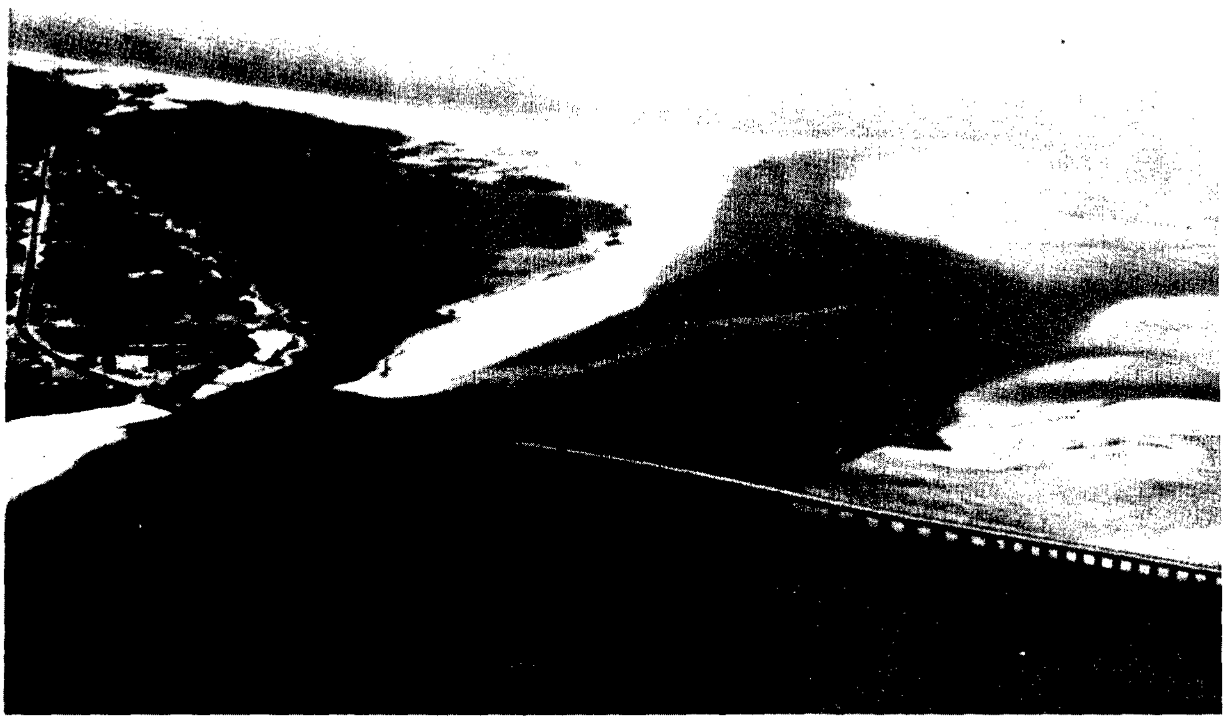
Although previously mentioned, and not to be understated, the purpose of the Atlas Echo-Sounder is to build confidence in digital recording and thereby complement the HYDRA II Survey System in its prototype form.

2. Test Objectives

The objectives for this test and evaluation effort were to thoroughly rate field performance of the modified HYDRA II Survey System and to train NAVOCEANO

FIGURE 16. HYDRA I RACKS ON PIER AT AUTEC SITE 1

T & E MODIFIED HYDRA SURVEY SYSTEM



DESTIN, FLORIDA

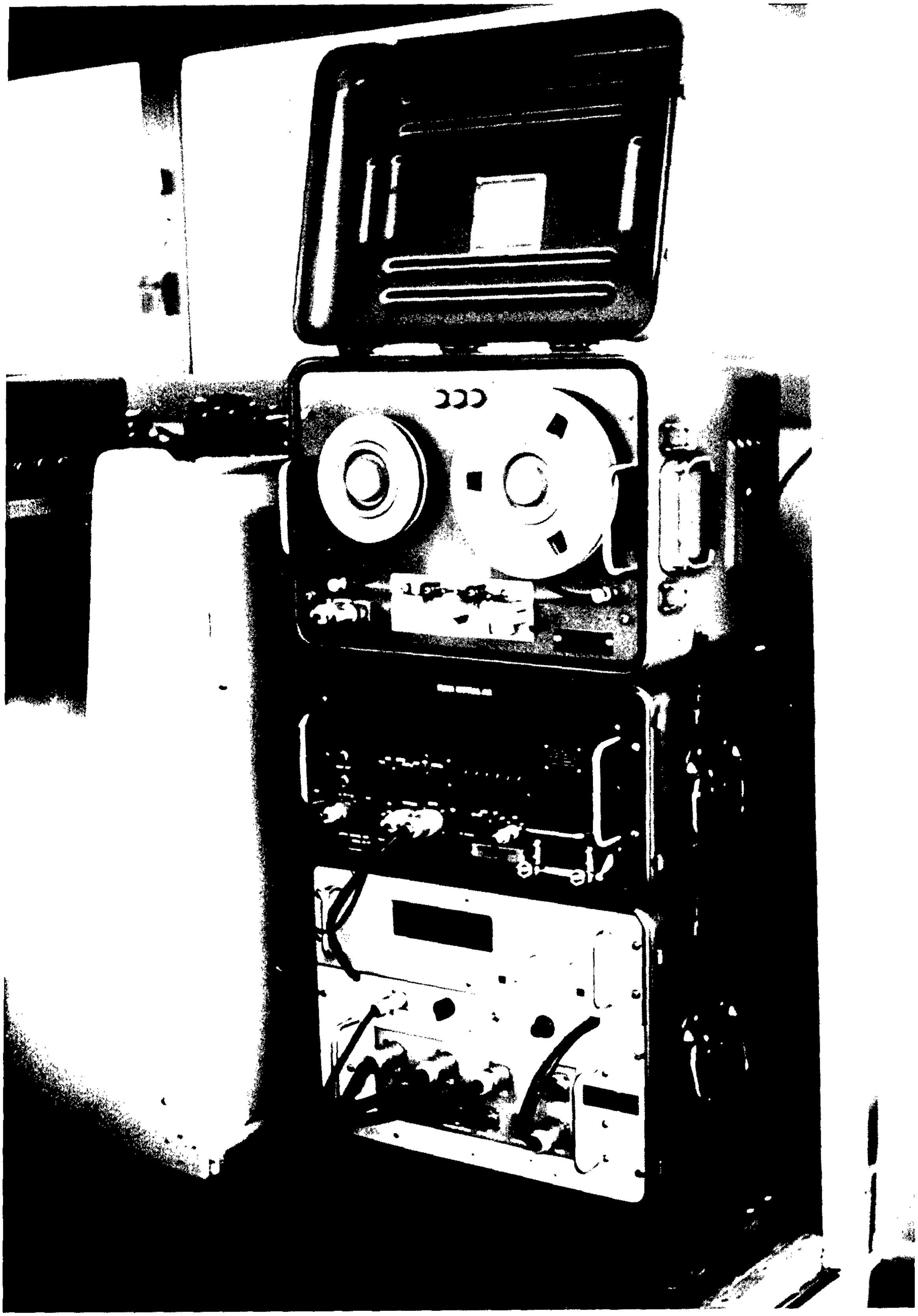


FIGURE 17. THE MODIFIED HYDRA SURVEY SYSTEM (HYDRA II)

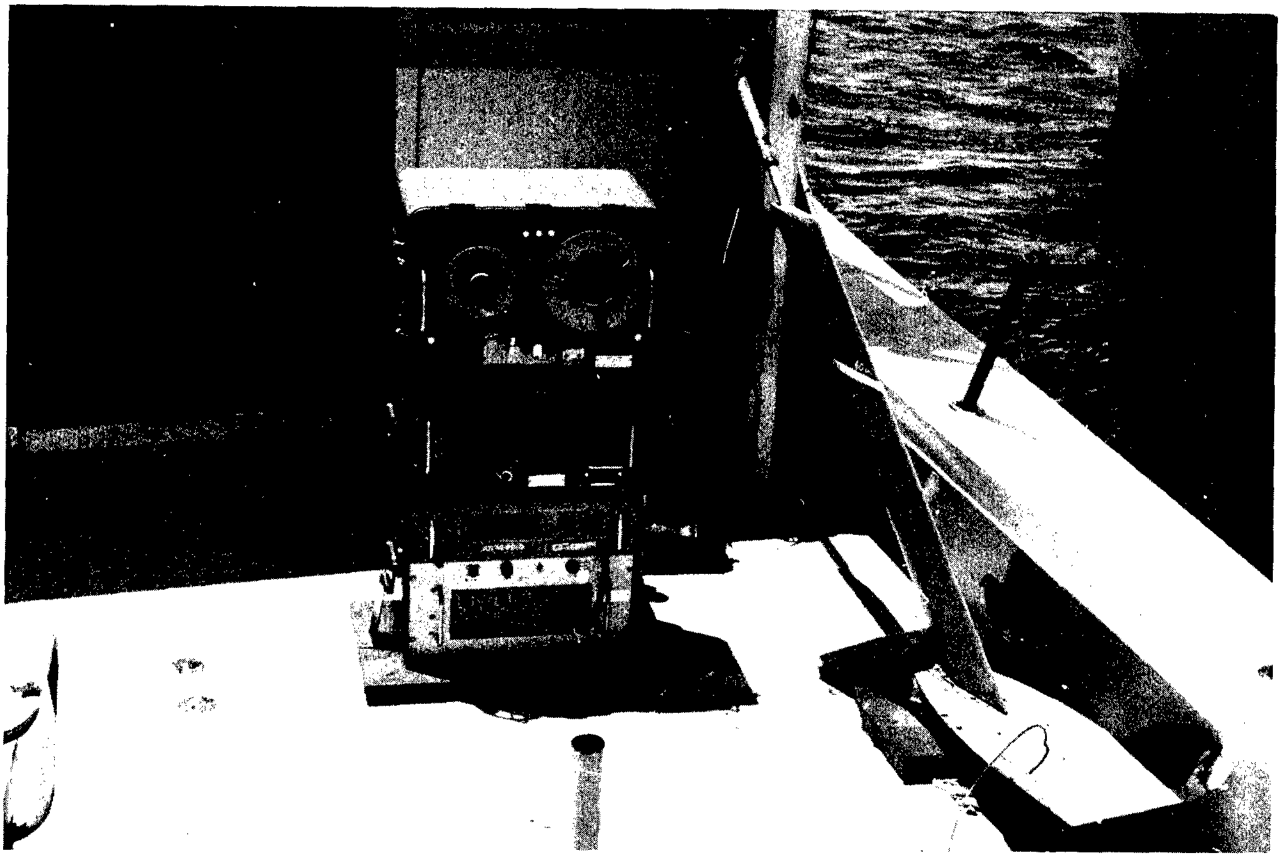


FIGURE 18. HYDRA II SURVEY SYSTEM DEPICTING ASSEMBLED "ZERO" TYPE CONTAINERS

FIGURE 19. ATLAS ECHO-SOUNDER ANALOG PORTRAYAL SUB-SYSTEM

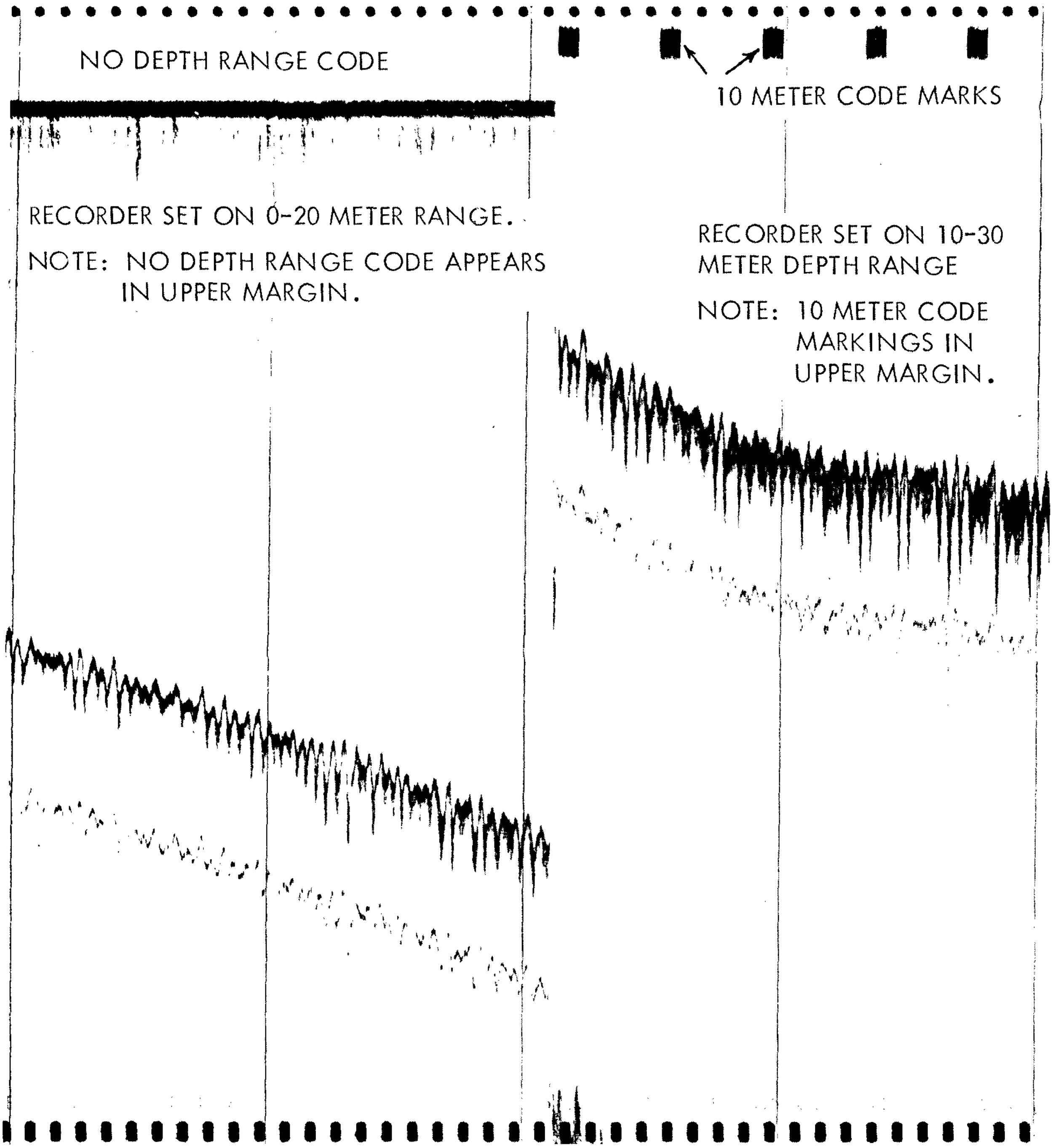


FIGURE 20. FATHOGRAM DEPICTING INCREMENTAL SCALE CHANGE

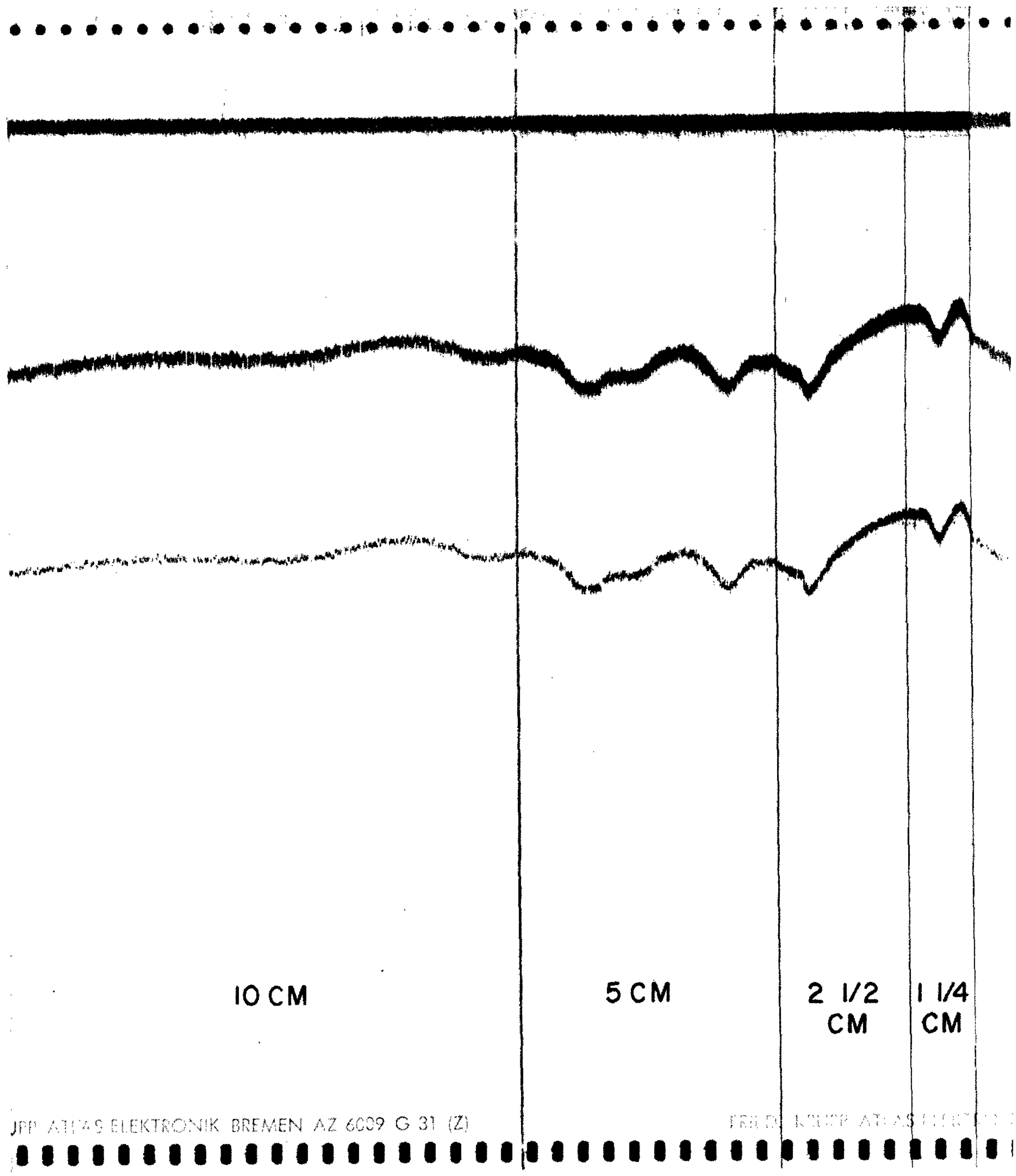


FIGURE 21. FATHOGRAM DEPICTING VARIABLE PAPER SPEEDS IN CENTIMETERS PER-MINUTE

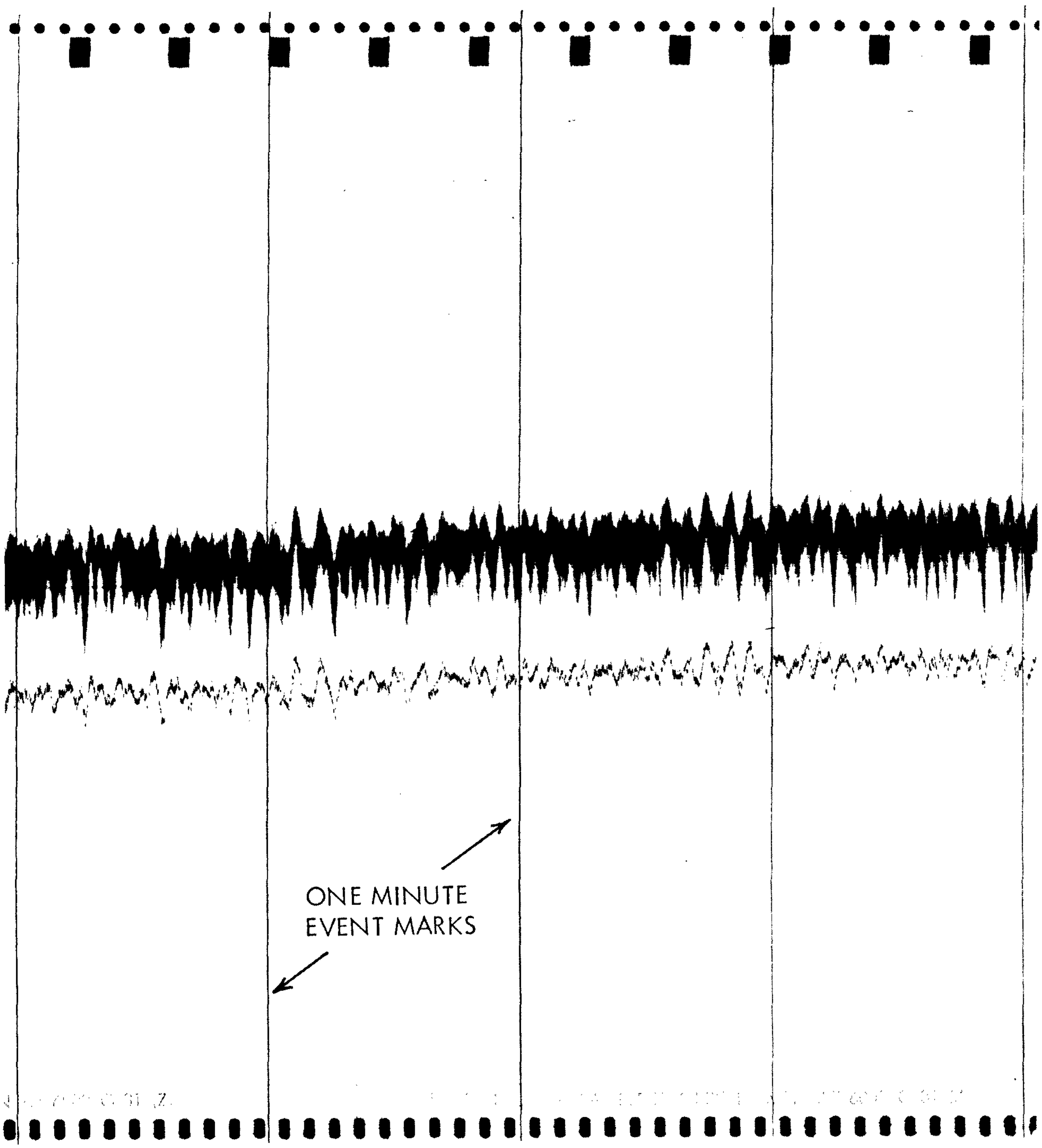


FIGURE 22. FATHOGRAM DEPICTING ONE MINUTE EVENT MARKS

R&D personnel in operational and routine field maintenance procedures. When the system is deployed to Vietnam, proper guidance and instruction will be given to the Riverine Survey Team in operational procedures of the equipment.

3. Field Tests, Results, and Evaluations

The site chosen for tests of the HYDRA II System was Destin, Florida (see Figure 23). Specific reasons for the selection of this site were twofold; first, the excellent areal coverage from the Eglin Air Force Base Decca electronic positioning net (see Figure 24), and secondly, the availability of computer facilities at the Naval Mine Defense Laboratory, Panama City, Florida. The time period selected for the tests was 4 May - 18 May 1968.

Upon arrival in Destin, Florida, efforts were made to charter a boat that would satisfy space and mounting requirements for installation of the HYDRA II System. The charter boat "Wahoo" operating out of Destin was selected for the test survey craft as it fully satisfied these requirements. Loading and installation of the HYDRA II aboard the "Wahoo" (see Figure 25 and 26) was completed in under 30 minutes as compared to three hours for loading the prototype HYDRA I System at AUTEC. While loading HYDRA I required the use of a hydraulic crane, HYDRA II was hand carried aboard the "Wahoo" by two R&D personnel, thus physically illustrating the effect of the modifications in weight and packaging.

During initial debugging, a malfunction occurred in the Atlas Echo-Sounder which produced erroneous depth readings on the nixie display. After examination of the circuitry in this unit, it was determined that two integrated circuits were faulty and repairs were quickly made.

Test survey operations were made on a daily basis throughout the remainder of the T&E effort. At the conclusion of the tests, nine reels of magnetic tape had been generated. Results indicate that the modified HYDRA II Survey System has lived up to its expectations.

During test survey operations, a series of Decca and optical position comparisons were made in order to determine to what extent, if any, random errors occurred in the Decca fixes. A technique, using optical tracking instruments, was performed at three positions in the Gulf of Mexico. Two azimuth measuring devices were set up eccentric to Elgin AFB Tracking Towers No. 114 and No. D100. Six sets of simultaneous observations were taken on the test craft "Wahoo" at each position while laying to. Geographic positions of the boat were computed from these single observations and compared to the Decca values.

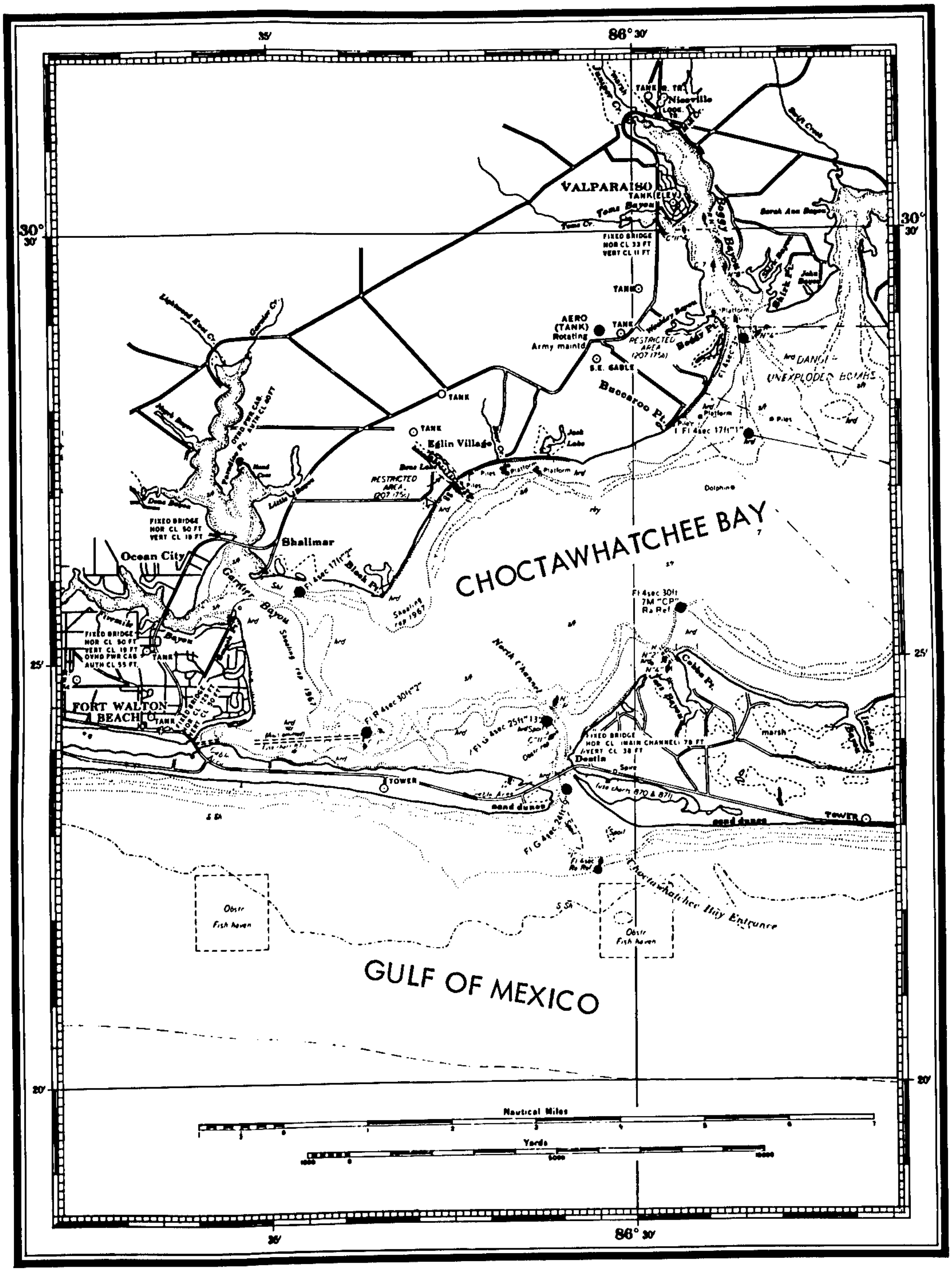


FIGURE 23. SURVEY AREA (DESTIN, FLORIDA)

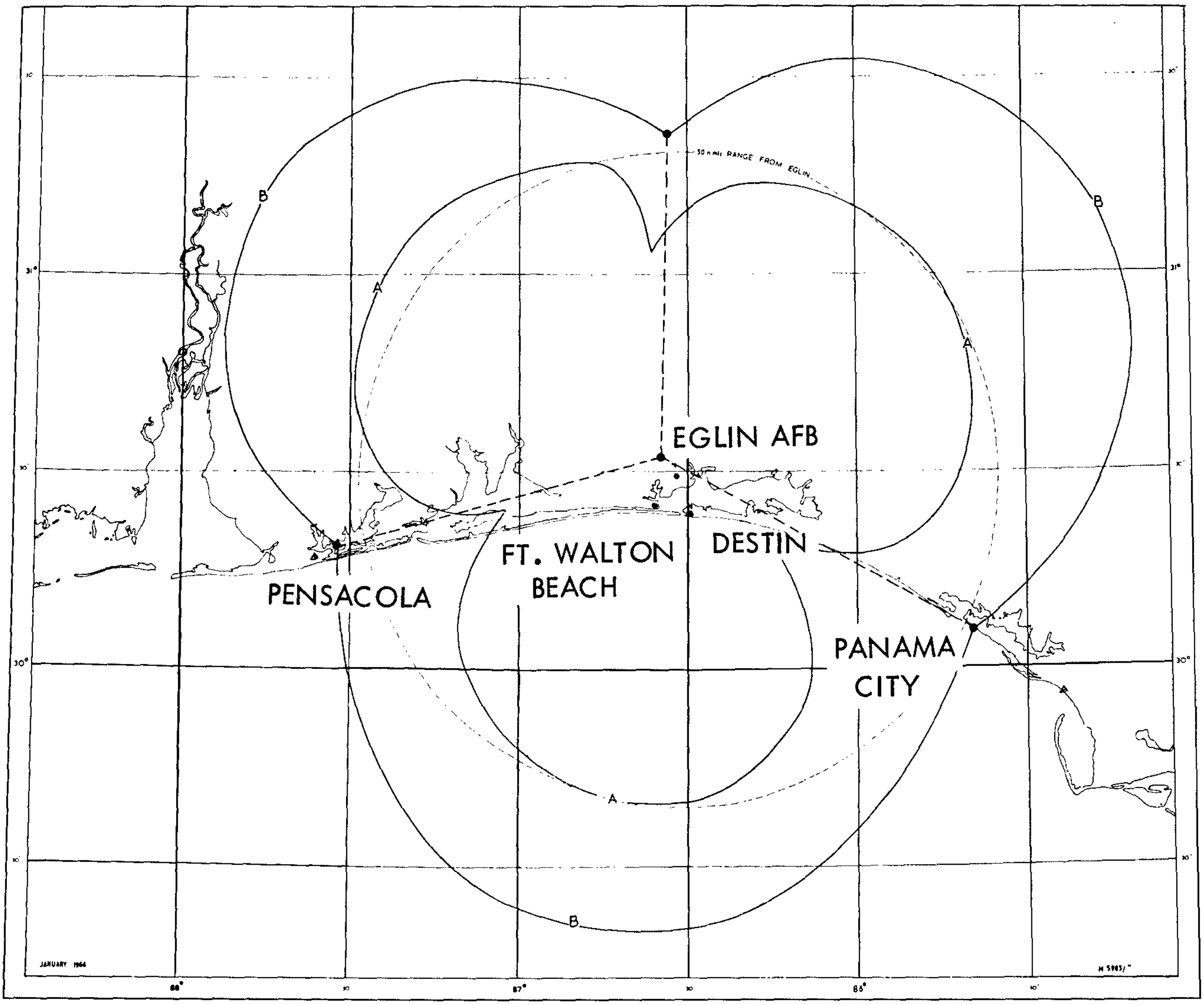


FIGURE 24. COVERAGE DIAGRAM OF EGLIN AIR FORCE BASE DECCA NET

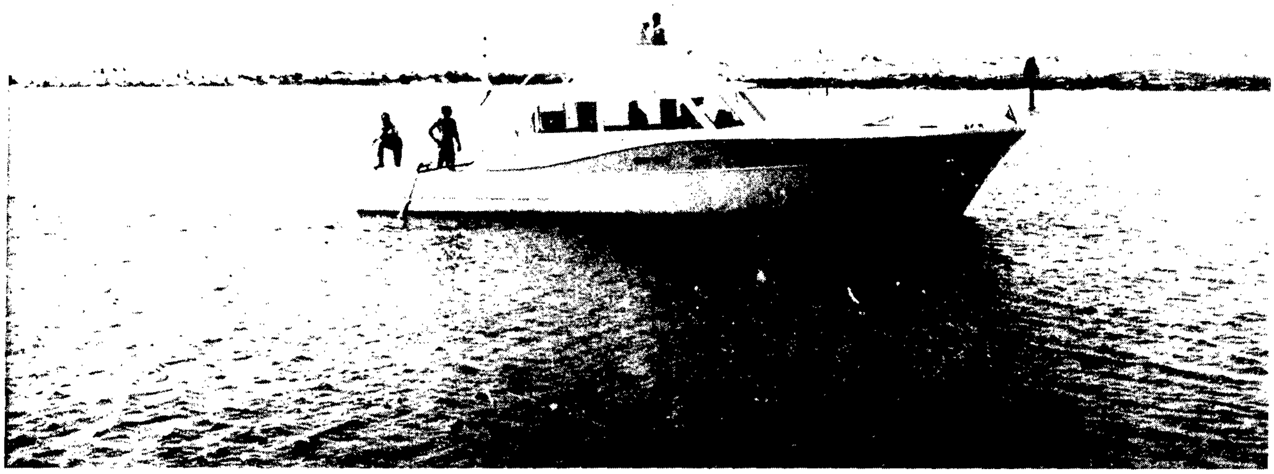


FIGURE 25. SURVEY CRAFT "WAHOO" WITH TRANSDUCER MOUNTED OVER-THE-SIDE

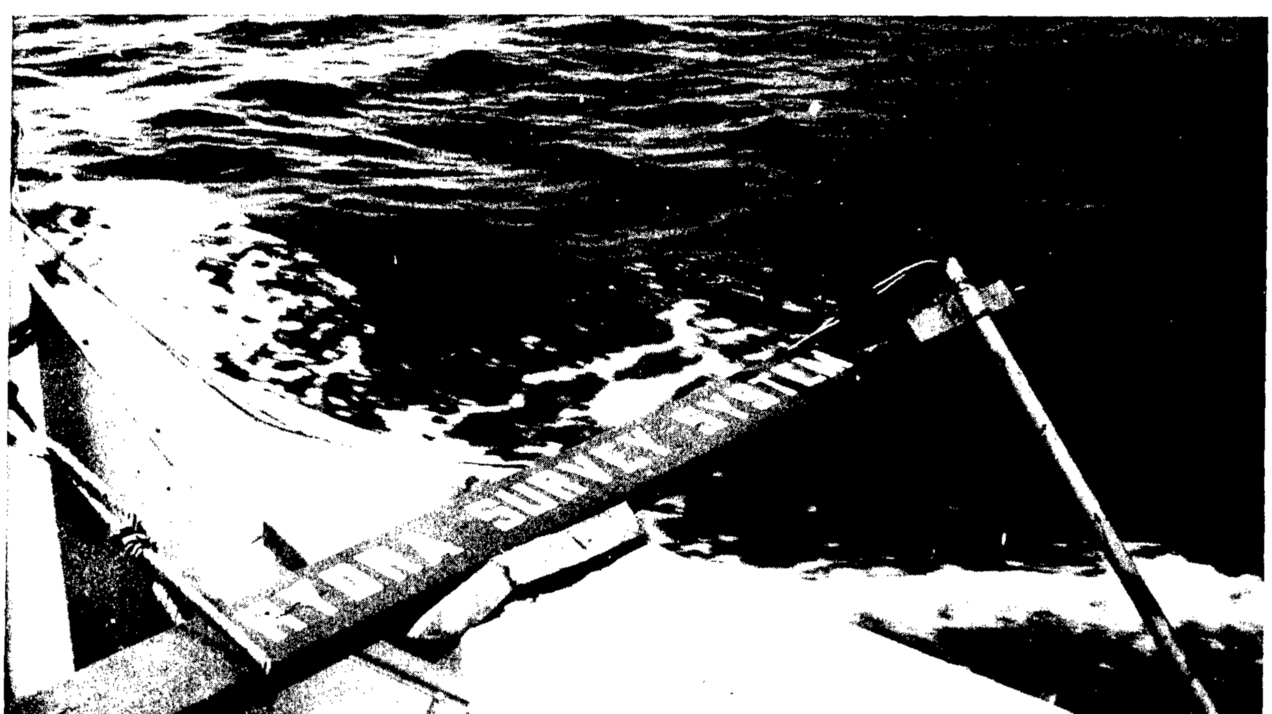


FIGURE 26. SIDE MOUNTING OF ATLAS TRANSDUCER

The results of these comparisons were not of sufficient duration to determine the quantity of random errors such as seasonal or atmospheric variations in the Decca lines of position. The systematic errors of the hyperbolic lines of position induced by overland transmission is approximated by this technique.

CONCLUSIONS AND FUTURE APPLICATIONS

Although the HYDRA Survey System has been developed in direct response to the urgent riverine survey requirements in Vietnam, the potential applications for such an automated digital survey system are almost unlimited. A portable self-contained survey system with its associated mobile data reduction and processing facility could be airlifted to any point in the world within hours. Only one or two technicians would be required to make the system operational. In areas without available electronic positioning, portable stations such as Sea-Fix, could be established. From a military standpoint such a capability would greatly enhance the effectiveness and success of future amphibious operations by providing field commanders with accurate on-the-scene hydrographic intelligence.

With certain modifications the HYDRA Survey System could be used in more conventional hydrographic surveys. The modifications would include adding a Digital Control Unit to the system that would accept Hi-Fix and Sea-Fix electronic positioning. This would give the system accuracy capabilities within the magnitude required for conventional hydrographic surveying.

The Decca electronic positioning system currently being used for HYDRA has a fix or position accuracy in the range of 25 to 150 yards during the best receiving periods, and a service range of approximately 250 miles. In contrast to this, the Sea-Fix and Hi-Fix portable electronic positioning systems, also manufactured by Decca, are capable of fix accuracies of 1 to 15 yards, depending on the type of transmitter, mode of operation, and the area of the electronic "net" being used. The service range of Hi-Fix is 25 nautical miles for the low power sets (10 watts) to 200 nautical miles for medium power sets (40 watts), when used in areas of low signal to noise ratio. Sea-Fix, a light weight, one watt system designed primarily for mounting in buoys, has a predicted service range of 20 to 50 nautical miles. The concept of mounting Sea-Fix transmitters in buoys is still in the development stage. When fully developed, the buoy mounted concept will provide the HYDRA Survey System with an even greater versatility for conventional hydrographic surveying.

Another application of HYDRA technology is in conjunction with the development of the Hydrographic Survey and Charting System (HYSURCH). HYSURCH will provide a capability for satisfying urgent military operational requirements for hydrographic acquisition, correlation, compilation, reproduction, and dissemination of data. The system will consist of the following subsystems: aerial survey, hydrographic survey, and cartographic compilation and reprodution. Techniques and equipment developed in the HYDRA system will contribute to the development of the integrated HYSURCH hydrographic survey sub-system.

These and many other potential applications for the HYDRA Survey System are currently under consideration by NAVOCEANO's Research and Development Department. As the state-of-the-art developes in digital data acquisitioning and data processing, conventional survey operations as we know them will give way to a new breed of high speed survey craft for both surface and airborne sensors. The HYDRA Survey System as outlined in this report is but a start in that direction.

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13. ABSTRACT

The U. S. Naval Oceanographic Office (NAVOCEANO) received an urgent requirement in November of 1966 to conduct reconnaissance hydrographic surveys of the rivers and canals in the Mekong Delta of South Vietnam. As an interim measure NAVOCEANO tasked a Riverine Survey Team (RST), made up of both civilian and military personnel, in order to fulfill the immediate military/hydrographic requirements. The magnitude of the project revealed the need for a new approach to data acquisition, as conventional survey methods were too time-consuming and did not lend themselves to the widely varying environmental conditions found in the hostile Mekong Delta.

A prototype hydrographic digital positioning and depth recording system (HYDRA Survey System), compatible with existing electronic positioning systems and capable of data acquisition at speeds in excess of 20 knots, has been developed by the Research and Development Department of the U. S. Naval Oceanographic Office. This system is especially designed for military survey area applications.

The function of the HYDRA Survey System is to acquire electronic position and depth information, correlated with time, in a format suitable for automatic data processing and plotting on survey charts in the field.

Results of experimental test surveys conducted with the prototype HYDRA Survey System (HYDRA I) at AUTEC Site 1 in the Bahamas, and the modified HYDRA Survey System (HYDRA II) near Ft. Walton Beach, Florida, are highlighted with special emphasis given to future applications.

14. KEY WORDS	LINK A		LINK B		LINK C	
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DEVELOPMENT, TEST AND EVALUATION						